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FUNDAMENTALS
of
EDUCATIONAL PSYCHOLOGY

By

O. B. DOUGLAS, Ph.D.

ASSOCIATE PROFESSOR OF EDUCATIONAL PSYCHOLOGY, UNIVERSITY OF TEXAS

and

B. F. HOLLAND, Ph.D.

ASSISTANT PROFESSOR OF EDUCATIONAL PSYCHOLOGY, UNIVERSITY OF TEXAS

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PART I

THE SUBJECT MATTER AND SCIENTIFIC BASES OF EDUCATIONAL PSYCHOLOGY

Nature and Purpose of Part I

Nature

Part I of this text consists of two chapters. The first deals with the general character and nature of the subject matter, and with its relation to other fields of knowledge. The second deals with the scientific bases of educational psychology. Chapter I, for instance, presents two definitions of *education*, concentrates attention upon the one which describes the term in reference to a body of knowledge concerning school problems, and proceeds to expand this idea. It also presents the meaning of *psychology* and expands this meaning to cover a number of specialized fields of which educational psychology is one. Then follows a statement of the meaning of educational psychology as a branch of education and as a branch of psychology.

Chapter II enlarges upon the meaning of science in general, and shows how educational psychologists collect and interpret materials. Considerable emphasis is placed upon scientific method, and the methods employed in collecting data which serve as the basis for the science of educational psychology. In showing the place of hypotheses in the development of science, attention is concentrated upon the basic hypothesis underlying the content of educational psychology.

Purpose

The purpose of Part I is two-fold: (a) It is intended as a general introduction to education and psychology by which the student can orient his thinking in the two fields. (b) It aims at helping the student approach the study of educational psychology as a science. Too many people think of education as a hodge-podge of anecdotes regarding methods of teaching or of handling pupils in school. Since workers in the field of educa-

tional psychology are striving to present a systematic, accurate account of pupil nature and conduct, the student should approach the study of the subject with the same viewpoint.

Suggestions for Study

Student Problems

NEWNESS OF THE SUBJECT MATTER. Beginning students of educational psychology, for whom this text has been prepared, usually find the subject matter new and strange. It is new in the sense that many of the topics are treated from a highly specialized point of view. Many of the topics have been met in a variety of settings, but the student, as a rule, has not met them as materials to be learned and related to each other in special systems of thinking. The student is also confronted with many words that he has been accustomed to using in a variety of contexts, but which he is expected to know here as technical terms. This type of newness usually makes the subject matter of educational psychology seem familiar to the student, so that he usually thinks he knows more about it than carefully constructed tests reveal. Because of this, the student is cautioned not to assume a "passable knowledge" of the subject. He should recognize that he is confronted with the problem of acquiring a relatively new field of subject matter for which he has had little, if any, high school preparation.

Study Problems

In all probability, the chief problem confronting the beginning student in educational psychology is that of acquiring the meaning of its terms. For this reason, it is wise to make every chapter title and topic heading an object of close scrutiny and study. It is also wise to pay close attention to italicized phrases and words. After this is done, the student should study the ways in which the general and specific topics are related to each other, and the manner in which each term is repeatedly used with the same meaning. Above all things, the student should try to grasp the theme or themes of the text, and note the manner in which these are carried forward in each chapter and in each topic. By doing these things, the student will go a long way toward solving the problem of learning how to think in this field.

CHAPTER I

EDUCATIONAL PSYCHOLOGY AND RELATED FIELDS OF KNOWLEDGE

INTRODUCTION

Purpose of the Chapter

The purpose of this chapter is twofold: (a) to suggest to the student the nature and scope of the subject matter treated in this text, and (b) to show the relation of this to other fields of knowledge. This text deals, of course, with the elements of educational psychology; and this field of study is closely related both to education and psychology. In fact, it is a branch, part, or division of these two bodies of knowledge. In order to achieve the purposes at hand, therefore, we need to discuss the general nature of each of these broader fields of knowledge. The object of this type of discussion is to give to the student, at the outset, a comprehensive view of the entire field of education and psychology.

Meaning of Education

The term "education" has many meanings, two of which may be distinguished here. The term is used (a) to designate all the *changes that take place in an individual* during the course of his life, and (b) to refer to the *body of knowledge* concerning the nature of these changes and also to the institutions, agencies, methods, etc., that exist to effect them. In order to make these meanings clearer, we may consider each in some detail.

Education as Change

When a person is born, he is weak, helpless, and ignorant. Being so, he is dependent upon others for all the necessities of life. Except to grow physically, he does little, he accomplishes little, and understands almost nothing. For this reason, we say that the infant is ***un-adapted*** or ***un-adjusted*** to his ***environment.***

During the course of life, however, the individual undergoes a multitude of changes. With the help of others, and because of various inner factors, he becomes increasingly capable of supplying his own needs and of understanding the world in which he lives. He may even reach a stage of growth and development at which he is able to help others undergo changes similar to those that have taken place in himself. All such changes are designated by the term *education.* (12)

Another term used to designate the changes that take place in an individual is *adjustment,* or *adaptation.* Either of these terms refers to the process by which the individual is brought into proper relationship with the forces and influences about him. The forces and influences that surround the individual and that affect him in any way are included by the term *environment.* The term *adjustment* implies, therefore, the bringing about of needed or desirable changes in the individual that will enable him to fit into his environment. When such changes are not brought about, the individual is said to be un-adjusted, ill-adjusted, or mal-adjusted.

Those persons who assist individuals in adjusting to their environments are known as *educators.* The institutions in which such persons work, namely, homes, schools, clubs, churches, and the like, are called *educational institutions.* In a broad sense, such persons as parents, ministers, editors, and writers are educators; but in a more restricted sense, only those persons connected with schools in the capacity of superintendents, principals, supervisors, teachers, and others are called educators. In other words, the term *educator* is used most frequently to refer to persons who are especially trained for the purpose of helping others adjust to their environments.

Education as a Body of Knowledge: The Science of Education

In a restricted sense, the term *education* is used to designate a body of knowledge concerning educational institutions, pupils, methods of teaching, problems confronting educators, and a vast number of related topics. This body of knowledge has been accumulated by many investigators interested in the improvement of all types of educational work. Research workers, persons in search of new facts and principles, have made many special studies of problems confronting educators; and educators

in service have discovered through practical experience a wealth of information concerning their tasks. Knowledge accumulated from these sources is made available to other persons at educational conferences and associations, and in journals, textbooks, lectures, newspapers, etc. For the purpose of helping students who are interested in preparing themselves for educational service, colleges and universities, through professors and lecturers, offer a large number and variety of courses of instruction; and in the larger colleges and universities, advanced students are assisted in making special studies of educational problems and procedures. All such information or material of special interest to educators or prospective educators is known as *education*, or the *science of education*. When we apply the term *science* to education, we should have in mind only the most accurate, reliable, fully sifted, and thoroughly tested information; for this is the only type of information in any field to which the term science should be applied.

Meaning of Educational Psychology

General

The student can see already that educational psychology is a field of knowledge that occupies approximately a midway position between education and psychology. It deals with the problems confronting educators, on the one hand, and with the study of pupils, on the other. In so far as educational psychology deals with educational processes, it is a branch or division of education; and in so far as it concentrates attention on the nature and behavior of pupils, it is a branch of psychology.

Definition

As a working definition of educational psychology, the following may serve the purpose of this text: It is the science that deals with the nature and the behavior of pupils or persons who are being educated. The term *nature* may be taken to include the observable characteristics of individuals, and *behavior* to refer to what they do, particularly in the school environment. The object of such a study is to furnish the educator, or prospective educator, with a body of information concerning pupils, and

to indicate how this knowledge may be used in assisting the pupils to adjust to the aspects of environment represented by the school or other educational institution. (7)

BRANCHES OF EDUCATION

In order that the student may comprehend the fact that educational psychology is only a small portion of the entire field of education, an effort will be made to describe the other branches or divisions. Such a description should also enable the student to secure a comprehensive view of those materials that are now available for those who expect to engage in educational service.

Educational Administration

Meaning

The term *administration*, applied to education, is used to include a large group of activities involved in managing a school or school system; in determining its policies and objectives; in raising and expending funds; in selecting, organizing, and guiding the personnel of the faculty; in managing the institution; and in providing for the improvement of its services. Courses of instruction which deal with information related to these activities include the nature of the organization; its general policies, programs, and services; its purposes, functions, and methods; the duties of individuals composing the personnel; its material resources; and its limitations. (11)

Persons Interested

Those who pursue courses of instruction in educational administration are persons who expect to become members of school boards; superintendents, principals, or supervisors; or those who expect to improve their knowledge of the duties and responsibilities of these positions.

The Art of Teaching

Description

This name is given to a branch of education concerned largely with the materials and methods of teaching in the various grades. Courses of instruction include studies of what to teach

in each grade; how to teach the materials selected; how to manage classrooms; how to deal with pupils of different ages and grades; what to do in cases of discipline; and other similar topics. The study of such information is usually supplemented with actual practice teaching. This is ordinarily done in a "practice school" attached to the college or university, or in the public schools nearby, and under the direction and observation of a professor and a critic teacher.

Those who study in this field usually select courses of instruction which deal with elementary or secondary education. Elementary education ordinarily includes the training given to children in grades ranging from nursery school through the sixth grade. Secondary education consists of instruction and training given in grades seven to twelve. These are usually designated as junior and senior high schools. (11)

Persons Interested

Frequently courses of instruction in this field are organized to meet the needs of principals and supervisors of elementary and secondary schools, or of persons who expect to serve in these capacities. More frequently, however, these courses are intended primarily for prospective classroom teachers.

History of Education

Description

The history of education is concerned with the problems of education in the past. It attempts to show the origin and development of different types of schools, theories and practices, methods and materials, subjects, and the like, showing how peoples at one time or another have provided for the education and training of their children. It also stresses the educational thought and services of outstanding thinkers and of great teachers whose ideas and methods have had much influence on modern ideas and practices.

Persons Interested

The history of education is of interest to persons who wish to obtain a broad view of education in general. It is of particular value in helping to discover those ideas and practices that have

succeeded and those that have failed, with the view of understanding present ideas and practices.

Philosophy of Education

Meaning

The term *philosophy* originally meant love (phil) of wisdom (sophia). In its widest sense, it refers now to a many-sided branch of learning which investigates such problems as the ultimate nature of things (metaphysics), the nature and sources of knowledge (epistemology), the most general principles of learning (logic), and how one ought to act (ethics). Philosophy is distinguished from science in that it does not attempt to collect original data or facts but utilizes those that are already available. Whereas science attempts to collect data in particular fields of investigation through careful observation, philosophy brings available data and principles together and shows their mutual relationships by means of logical deductions.

The *philosophy of education*, therefore, is a branch of learning that attempts to organize all of the ideas about education into a systematic way of thinking about many problems in the entire field. It considers such general problems as the aims of education, the values of different school subjects, the relation of the school to society, the advantages and disadvantages of various practices and theories, and the development of thinking in regard to education. Much attention is usually given to a study of the ideas about education held by outstanding thinkers, both of the past and present, and to the evaluation of the various ideas proposed.

Persons Interested

The philosophy of education is of primary interest to graduate students who feel a need of working out ideas of their own. Since it covers such a wide field of knowledge, very few undergraduates attempt to study in this branch of education.

Physical Education

Subject Matter

Physical education consists of knowledge related to the physical nature, development, and welfare of pupils. It is not

a field primarily concerned with physiology and hygiene, but it selects from these subjects materials of interest to educators. It is also concerned with the direction and supervision of games and playground activities suited to children of different ages, and with sports such as basketball, football, baseball, and tennis, that are usually associated with school life.

Persons Interested

The field of physical education is of special interest to persons who expect to direct the play activities of pupils, or who expect to serve in the schools as athletic coaches and directors of physical training.

Physical education, as a special field of study, is relatively new. It has enjoyed much growth in recent years, and it is rapidly becoming one of the most important divisions of education, especially so if we judge it from the standpoint of the number of persons who are interested in it.

Other Branches of Education

The divisions of education described above are the fields of study most frequently represented by courses of instruction in colleges and universities. These, however, are not the only branches which exist. Students who wish to specialize for particular types of educational service will find other courses offered under such headings as the following:

Guidance

As a separate and distinct branch of education, guidance is a product of recent times. It has to do with helping pupils in special problems with which they experience unusual difficulty. These problems are concerned with difficulties that arise in the classroom, personal relationships between pupil and teacher, choice of courses in school, choice of college to attend and courses to take, choice of a life work, etc. While much guidance is given by the classroom teacher, it is probably wise to employ a specialist who has pursued special training in the field, or who has pursued courses in "guidance." (11)

Vocational Education

This branch of education deals mainly with principles, methods, and provisions for training pupils for non-professional occupations and trades. It deals, in particular, with the preparation of teachers for service in evening or part-time schools, agricultural schools, home-making schools, commercial schools, and the like. This type of education is also new in our country. Considerable interest is being manifested in it by students because of the constantly increasing number of persons who wish to continue their education upon dropping out of or finishing the regular day schools. (11)

Adult Education

The expression *adult education* refers to the instruction and training provided for persons beyond school age who cannot attend a college or university. Because of the great number of persons who desire this type of training, many students who expect to teach desire to prepare for this type of teaching rather than for regular elementary or secondary school service. Consequently, there has grown up a body of knowledge related to the problems confronting persons who serve society in this way. This knowledge is the basis of *adult education.* (11)

Rural Education

Because of the special types of problems arising in connection with the teaching services peculiar to rural schools, courses of instruction may be pursued in the field of *rural education.* This type of education deals with teaching, administrative work, supervision of instruction, and special types of services usually connected with rural schools. It is intended, of course, for persons who expect to teach in rural communities. (11)

Character Education

In recent years, there has grown up a practice in public schools of giving children instruction designed to cultivate moral and spiritual ideals and habits. It is thought wise by many leaders in education to assign this type of instruction to teachers especially trained for the work. As a result of this emphasis, there is now a body of knowledge which deals with

the problems, methods, and provisions for this type of service. This is usually designated as *character education.* (11)

Opportunity Education

In many of the larger cities special provisions are made for the education and training of exceptional children. These are children who, for one reason or another, do not fit into the regular program of the school, and who need special attention. All of these children may be placed in a special room, or in a separate school, with special teachers who are prepared to deal with problem cases. This type of service on the part of the teacher is so different from that of the regular classroom teacher that special training is needed for it. In order to supply this need, colleges and universities often provide special courses dealing with the problems, materials, and principles involved. This type of training is usually called *clinical* or *opportunity* education. In many instances these problems are dealt with in the courses in guidance. (11)

There are other types of education now offered in colleges and universities, but the above represent those most commonly found. From the brief description offered of each type of education, the student may see that the science of education is exceedingly broad. It covers, indeed, all of the special provisions made by social agencies for the purpose of assisting individuals in adjusting to a complicated environment.

Educational Psychology and Other Branches of Education

While educational psychology is considered a separate branch of education, somewhat distinct from those described, it is closely related to each of them. Having to do with the nature, needs, characteristics, abilities, capacities, and behavior of pupils, it furnishes materials of interest to any person who expects to engage in educational service. An administrator, for instance, must know many things about pupils before he can organize and manage a school or school system in terms of the pupils. If he lacks this information, he may lose sight of the pupils, and give too much attention to the school as an organization. In order to make the organization function as an educational institution, every part of it must be planned and operated for the pupils; not for the superintendent and teachers, nor for

the school board and patrons. Before a teacher can perform his duties efficiently, he needs to make a study of his pupils. A teacher may know his subject well, and he may understand the nature and use of various methods of teaching; but if he does not understand his pupils, he will probably make a failure of his task. To know a subject is one thing, and to make this subject fit the pupils is another. To understand a method or device of teaching is good, but methods and devices have to be chosen in terms of the capacities and interests of pupils. Since educational psychology is concerned with the study of pupils, it seems, therefore, a vital part of the information needed by those who expect to engage in educational service. Educational psychologists insist that all educational provisions, methods, and devices must center in the pupils.

PSYCHOLOGY AND ITS DIVISIONS

It is not the purpose of the discussion that follows to name and describe all of the divisions of psychology; attention will be called only to those branches which are most closely related to educational psychology. The purpose in doing this is to indicate to the student the vast body of material represented by psychology, and to show how educational psychology is related to the other branches of this science.

General Psychology

The term *general psychology* describes a type of subject matter that is somewhat traditional, having become psychology as a result of the interest of students in how human beings acquire ideas. This was originally a problem of philosophy, and psychology was a branch of philosophy; but in recent years psychology has been separated from philosophy. The separation resulted from efforts made by psychologists to study mental life by means of experiments and other scientific procedures. These methods differed so markedly from speculation and logical deduction, used as methods in philosophy, that the two fields of inquiry drifted apart. Philosophy now concerns itself with the ultimate nature of knowledge; and psychology, on the other hand, deals with the immediate nature of knowledge and how it is acquired.

The subject matter of general psychology, as we noted above,

is behavior and mental life. Such topics as the following are included in the science: (a) sensory processes, such as experiencing color, warmth, sound, pain, etc.; (b) neural (nervous), muscular and glandular behavior; and (c) various types of mental activity, such as perceiving, remembering, imagining, and thinking. How these forms of behavior and mental activity occur is the chief concern of the psychologist. General psychology is usually divided into several branches some of which are discussed below. (13)

Physiological Psychology

This branch of psychology is a study of the relation of physical processes, particularly neural or nervous activity, to behavior and thinking. It attempts to use the facts and principles of physiology, as well as the methods of psychology, in studying, understanding, and explaining how and why human beings behave and think as they do. This division of psychology came into existence largely as a result of efforts to refute the claims of phrenology. This doctrine held that "the faculties of the soul," characteristics of the mind, character traits, and the like were localized on the surface of the brain; that the better developed faculties and traits showed as bumps or protuberances on various parts of the brain, and thus on the skull; and that persons who knew the locations of these faculties could analyze the character and capacity of a person by feeling of his head. The doctrine had great vogue at one time, being used by charlatans to deceive people who wished to be "phrenologized." The only merit of the doctrine was that it led to numerous physiological studies, particularly to microscopic examinations of the cells and fibers of the nervous system, and to investigations of bodily and mental effects of injuries to, and diseases of, the brain. It led also to the beginnings of experiments upon animals, in which portions of brains were removed and the effects studied. These experiments, in turn, led to the use of various experimental procedures in studying human behavior and mental life, and this led eventually to a new type of psychology. (13)

Experimental Psychology

This division of psychology consists of information derived by the use of experiments in the study of human activities.

The earliest experiments involved the use of instruments which were designed to measure the effects of combining such things as colors, sounds, and odors. By means of a color wheel, for example, on which various amounts of different colors can be mixed by rotating them on a fast-moving disk, the effects of combining different amounts of color can be studied and the individual can be asked to report what he sees or experiences. Similarly, tuning forks, pipes, strings, and the like can be employed in studying the mental effects of various combinations of tones. These, as well as numerous other instruments, some of which were designed for measuring a large variety of muscular and glandular activities, constitute the equipment for a psychological laboratory, the first of which was established by Wilhelm Wundt in Germany in 1879. Since that time, laboratories for studying psychological processes have been established in all of the leading universities. As a result, experimental psychology is perhaps the most important division of the entire field of study. It has, at least, helped to hasten the separation from philosophy and to give psychology the status of an independent science. (13)

Animal Psychology

The study of the behavior of animals is another important branch of general psychology. One type of animal psychology deals with animal behavior for its own sake; another type studies animals for the sake of understanding humans. The first may be called *pure animal psychology*, the second *comparative psychology*. In comparative psychology, animals are selected as subjects of investigation because they are simpler and easier to control in experiments than are humans. The results obtained from a study of them also throw considerable light on human nature and conduct. For instance, much of our knowledge of physiology, of learning, and of the effects of such drives as hunger, thirst, and sex on behavior has been obtained from the study of animals. (5)

Child Psychology

This branch of psychology deals primarily with the nature and needs of children. It attempts to give an account of the development of social and mental behavior in the child by showing how the child adjusts to his environment at different stages of

growth. Since a large part of the child's life is spent in school, child psychology also deals with his behavior in the school environment. For this reason, much of what we have of this division is in reality educational psychology.

A very important division of child psychology is that which deals with exceptional children, such as the blind, hard-of-hearing and deaf, the especially gifted, feebleminded, delinquent, and crippled. These children present such unusual problems to educators that special courses of instruction are offered by universities to those who expect to teach them. The term "exceptional children" usually refers to the especially gifted, while the blind, deaf. and crippled are described as "handicapped children."

Individual Psychology

Individual psychology is devoted to the study of differences between individuals. Ordinary observation reveals that no two persons are alike in any one respect, and that wide differences appear when different individuals are compared. Individual psychology attempts to describe the nature, extent, and significance of such variations. Because of the extensive use of tests and scales for measuring different traits, this division of psychology is frequently called the division of *tests* and *measurements*. Like child psychology, this branch is frequently taught as educational psychology. (7)

Genetic Psychology

With the development of experimental and individual psychology, considerable interest has been taken in the changes in human beings which occur with an increase in age. Many psychologists have made efforts to describe the whole of human life by showing how various traits begin and develop through different stages. Such a description requires a careful study of individuals before birth and during the whole course of life. The knowledge or information derived from this type of study is known as *genetic psychology.*

Social Psychology

This branch of psychology consists of knowledge derived from the study of the behavior of individuals in groups or in

social situations. It describes the social groups and institutions which comprise human society, and attempts to show how these influence the mental life and conduct of the individuals who compose them. (7)

Abnormal Psychology

This branch of psychology deals with unusual types of human beings and their behavior. It attempts to discover the nature and characteristics of abnormal personality, hysteria, day-dreams, hallucinations, delusions, various types of fears, complexes, and the like. One branch of this field is the psychology of insanity. The study of persons afflicted in these and similar ways has been of great value in suggesting ways of dealing with insane persons, both in caring for them and in effecting partial and complete cures.

Another branch of abnormal psychology is known as *psycho-analysis* or *Freudianism*, named for its founder, Freud. This branch deals mainly with certain mental disorders. Freud discovered, for example, that many persons suffer from the effects of conflicting desires, repressed cravings, extreme feelings of inferiority, and numerous sex problems. He set about to study these and to find a means of curing persons afflicted by them. He finally discovered that many unconscious desires, impulses, fears, and the like could be discovered and even removed by persuading the patient to answer questions. These answers and other symptoms of behavior were then analyzed, and a procedure recommended. The Freudians claim that they can discover the cause of a malady, and frequently effect a cure by giving the patient various types of information and advice. In the practice of asking questions, we find the meaning of psycho-analysis—analysis of the mind. (13, 14)

Applied Psychology

Somewhat outside of the realm of the different types of general psychology discussed above, there is another group of psychologies which seeks to apply psychological facts and principles to particular lines of human interest and endeavor. Though each is somewhat independent of the others, the group as a whole is designated by the name, *applied psychology*. Considered as a whole, applied psychology borrows from general

psychology those facts and principles which will throw light on how to carry on one's profession or trade in order to get the best results. As examples of this field we may study a few of the separate branches. (6)

Legal Psychology

This is the psychology of law. It is concerned with a wide variety of topics of interest to persons in the legal profession. Lawyers, for example, wish to know how to influence juries. They desire to know whether to reconstruct crimes and let the jury decide guilt or innocence on the basis of facts, or to play upon the jury's sympathies or prejudices. Lawyers and others in the profession also need to understand the criminal mind, how to discover different forms of insanity, how to evaluate testimony in terms of the behavior of witnesses, how to question witnesses, how to detect innocence or guilt, etc. The study of these and many other similar problems has led to the discovery of numerous facts and ideas that are of assistance to those in the legal profession. (6)

Business Psychology

This branch is also known as the psychology of commerce. It has to do with many problems such as the following: how to advertize effectively; how to appeal to interests or motives in selling; how to select salesmen; how to organize a business; how to direct men and women in selling, working, meeting people, etc. The business man is constantly dealing with people of all kinds and descriptions whom he needs to know and understand. Business psychology is intended to help supply this need. (6)

Medical Psychology

In recent years physicians have become interested in psychological principles as a possible means for dealing more effectively with the sick. All physicians know that there is considerable "mental sickness," and many are becoming interested in developing practical principles for meeting such patients. These physicians or others borrow freely from abnormal psychology. Some use, in particular, the method of psycho-analysis. Many physicians depend upon change in location or environment; some rely upon "rest cures"; others try to change the

patient's habits of living and thinking; a few employ hypnosis. Those who specialize in the study of mental disorders and the bodily changes which accompany them are known as *psychiatrists*. These men have succeeded in establishing what is known as the *science of psychiatry*, and have gained considerable reputation as practitioners in diagnosing and dealing with mental diseases and infirmities. (6)

Educational Psychology as a Branch of Psychology

As Applied Psychology

Educational psychology is often considered an applied psychology. As such, it may be described as a body of information resulting from efforts made to apply the facts and principles of general psychology to the teaching process. Some of the older textbooks in the field discuss first the facts and principles of general psychology and then show how these may be used by the educator. Many of the textbooks which represent this view often prove to be textbooks of psychology which contain little or no reference to education. Courses of instruction in which these texts are used often leave the prospective teacher with some vague notion that psychology ought to be and can be used in teaching, but with very little knowledge as to how the applications should be made. In so far as this point of view deals with educational problems, however, it is of considerable value to the prospective teacher.

As a Branch of General Psychology

Educational psychology, from a second point of view, is a branch of general psychology. As such, it is a body of psychological facts and principles concerning individuals. That is, from among the numerous different subjects that psychology as a whole seeks to study, educational psychology selects the *pupil*, or person undergoing the processes of education. In order to get information about the pupil, educational psychology proceeds in two ways: (a) it borrows freely from the other branches of psychology, and (b) it attempts to study the behavior of the individual in educational situations by means of its own methods and techniques. As a borrower of materials, educational psychology is deeply indebted to each of the divi-

sions of general psychology described above. As a matter of fact it has practically taken over certain of the fields, such as child, individual, and genetic psychology; and it lays great stress on physiological and abnormal psychology. In doing this, however, educational psychology selects only those facts and principles of interest or of value to the educator.

In attempting to study the behavior of individuals in educational situations by means of its own methods, educational psychology has developed a body of information peculiarly its own. This body of knowledge exists as two branches, both of which are experimental in character. One is the field of mental and educational tests and measurements; the other is the field of the school subjects. The first is concerned with measuring the nature and amount of the changes effected in individuals by the processes of education. This is done by measuring such traits as character, skills, attitudes, reading ability, ability in geography, etc. The second, which deals with school subjects, consists of a variety of information concerning the processes involved in the mastery of such subjects as writing, reading, spelling, arithmetic, history, language, etc.

Work in these two fields, and others related to them, has yielded a body of data of such a high degree of accuracy, reliability, and usefulness that educational psychologists believe they are entitled to be known as scientists, and that their field of investigation should be called a science. How they seek to justify this belief and these claims will be set forth in the next chapter.

EXERCISES

1. Find the two meanings of *education* presented in the chapter and be able to discuss each.
2. Write out accurate and precise definitions of the following terms: scientist, educator, pupil, native, behavior, environment, adjustment.
3. Make a list of the teaching positions or lines of educational service described or suggested in the chapter. In which of these are you particularly interested? Why?
4. Which teaching positions require the greatest and which the least knowledge of educational psychology? Why?
5. Why is it necessary to divide the science of education into branches? Make a list of the main problems which each branch attempts to solve.

6. Make an outline of the divisions of psychology and list the topics usually included in each division. Show which divisions are of special interest to education.
7. What factors contributed to the separation of psychology from philosophy?
8. What professional people other than teachers usually have a definite interest in psychology? Are there any professional people who do not have this interest?
9. What two fields of investigation are peculiarly related to the subject matter of educational psychology?
10. In what branches of psychology is the educational psychologist particularly interested?
11. In selecting or borrowing subject matter from other fields of study, what guiding principle does the educational psychologist attempt to follow?
12. Discover and formulate the *theme* or main idea of Chapter I.

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CHAPTER II

SCIENTIFIC STANDARDS OF EDUCATIONAL PSYCHOLOGY

INTRODUCTION

Purpose of the Chapter

The specific purpose of this chapter is to call attention to the standards of procedure which govern the educational psychologist in his search for and organization of accurate and reliable information. It is also desirable to indicate to the student how educational psychology is being made a science, and to furnish him with a standard for estimating or judging the accuracy and reliability of information.

The standards of procedure followed by the educational psychologist, as well as the factors or points of view which determine the organization of his data and materials, are common to all sciences. It will be necessary, therefore, to describe here the nature of science in general, and to discuss its methods of investigation. It will also be desirable to indicate several types of scientific information, such as hypotheses, theories, and laws. These represent stages in the development of scientific truth and determine to a large extent the organization and systematization of specific data or facts. When these topics have been discussed, the student will be shown how investigators in the field of educational psychology endeavor to employ principles of scientific investigation in this field.

The Meaning of Science

The term science describes any body of verified knowledge considered as a special field of investigation in which the materials are obtained and systematized by investigators trained in obtaining and verifying particular items of information. Thus a student is pursuing the study of science whether he is engaged in the mastery of a particular body of knowledge or engaged in the mastery of the procedures employed in ac-

quiring knowledge. He masters science in the former sense by reading scientific books or journals or by listening to lectures; he masters science in the latter sense by gaining skill in the use of scientific procedures. While we may think of science in these two ways, we do not mean to imply that the two meanings are unrelated; on the contrary, the reverse is meant. In other words, it is impossible to conceive of verified knowledge without implying the means by which it is verified. (4)

Characteristics of Science as Knowledge

In characterizing science as subject matter, we need to notice certain facts about it. *First*, each science deals with a particular type of subject matter, or with certain objects or events. For instance, physics deals with *energy*, chemistry with *matter*, biology with *living things*, and psychology with the *behavior of human beings*. An investigator in one field is not interested primarily in the subjects or events studied in another, except in so far as a study of them would throw light on the nature of the things in which he is primarily interested. Thus each science deals with a particular subject matter or a group of related facts and principles. *Second*, the data or specific facts of science are secured by means of carefully controlled observations made by specially trained observers who are called *scientists*. These individuals choose the field in which they are to work and then devote themselves to the task of increasing the stock of information in that field. *Third*, each science contains items in the form of hypotheses and theories, and these assumptions may or may not be true. This is so because investigation has not been carried far enough to verify particular items, and because each scientist attempts to relate newly discovered items to those previously established. *Fourth*, scientific knowledge is as accurate, reliable, and definite as it is possible for trained investigators to make it. (6)

Scientific Method

While the term science is used to describe the general and systematic manner of working by which a scientist endeavors to establish scientific truths, we prefer to assign this meaning to the expression *scientific method*. This embraces all the ways and means employed in obtaining and interpreting data or

specific facts. Frequently the term "method" is used to describe a special manner of working to solve particular problems. In such instances, however, the term *procedure* is preferable. A general description of scientific method will help to clarify these definitions.

Regardless of the field in which he works, a scientist takes various steps somewhat as follows: (a) He selects a definite problem on which to work. The problem is one in his field, and one about which little is known or one which needs to be verified by additional study. (b) He surveys the literature of the field to discover facts or data that may help him in solving the problem. He notes pertinent materials and reserves them for purposes of interpretation later. (c) If he finds little or nothing that will solve the problem at hand, the investigator works out a definite procedure (method) whereby he can secure necessary data or facts. In deciding upon a procedure, he considers those that have previously been employed in solving similar problems. From these he selects one or more that will serve his purpose. He chooses the procedure that will isolate the factor or phenomenon to be studied from all other factors that might conceivably influence his data. This means that he will control the action of his subjects or objects in such a manner as to obtain records or measures of their performances which will constitute the data by which his problem can be solved. The records will be permanent ones, when possible, and the measures will be definite quantities that can be used in describing significant performances of the subjects or objects employed. The instruments, devices, or apparatus and the special ways in which they are employed for the purpose of obtaining permanent and accurate records constitute the investigator's *technique*, which is always important in his procedure. (d) As the observation proceeds, the investigator makes notes on his procedure and of the variations in the performances of his subjects. Later, he uses these notes in describing his procedure and results so that other investigators can repeat the observation with different subjects, and thus verify the findings or discover errors in the procedure. (e) After securing the records and measures, the investigator describes and explains them, presenting them to his readers in carefully constructed tables, charts, graphs, diagrams, or other convenient forms; and

then shows, in every helpful way, how they relate to the problem under consideration. (f) On the basis of this exact and precise treatment, the investigator reaches definite conclusions from his data; and these constitute the new facts, hypotheses, laws, or principles to be incorporated in the science. These must be logical inductions about which there is little or no basis for doubt regarding their soundness or truth. (g) The investigator usually interprets his conclusions in the light of existing knowledge and usually in terms of some basic hypothesis employed in the science in which he is working. (5)

While this is a very brief description of science and scientific method, it may help the student to comprehend the meaning of science. We shall now enlarge upon the meaning of some of the things that have been mentioned but which may need further clarification.

Hypotheses

Nearly all scientific truths originate as opinions or beliefs which may become useful hypotheses or eventually verified truths called laws and principles. An *opinion* is a conclusion or judgment based on guesses or observations admittedly insufficient to be the basis of certainty. A *belief* is a more nearly certain judgment based on considerable evidence. Belief is usually colored by emotional factors, prejudices, or intense desires for certain things to be true. An *hypothesis*, on the other hand, is a tentative conclusion or assumption based on scientific observation and is held as tentative only until additional information substantiates it or proves it to be false. Scientists make considerable use of hypotheses as working notions and even as explanatory principles. These uses suggest two types of hypotheses, which we shall describe here; (a) specific, and (b) basic. (3, 6)

Specific Hypotheses

A specific hypothesis is an assumption employed as an explanation of a particular group of related events, data, or facts, or as the solution of a given problem, in either a scientific investigation or a practical undertaking. As stated above, the scientist collects certain data or facts and from these draws particular conclusions. If he has the least doubt concerning

their truth, or if he realizes that they need further study or verification, he considers such conclusions as hypothetical. Moreover, the scientist may begin an investigation, having in mind the assumption or hypothesis which he wishes to verify. When he tests the assumption by accurate procedures, he either verifies it or discards it as false or worthless. If he finds it to be true, he often formulates it as a verified truth or as a law or a principle.

In such a practical situation as teaching, one must frequently rely upon an hypothesis to determine a particular course of action. If one is confronted with the task of teaching history, for example, he has to select certain facts to be presented, the method to use, the types of tests to employ, etc. Unfortunately, the teacher does not have at her command an array of scientific truths to serve as guides in selecting procedure. She is often forced to select the course of action on the basis of limited information. In doing this, she makes certain assumptions and proceeds with their application to the problem at hand. Later, like the scientist, she may discover an error in her assumption; or she may discover that she has acted wisely. In either case, she has been guided by an hypothesis.

Basic Hypotheses

A basic hypothesis is employed in each of the various sciences as a starting point and as a description of the fundamental character, nature, or essence of the object or forces studied. Not only does such an hypothesis serve as a starting point, but it also constitutes the fundamental idea underlying the science. To it all observed particulars are related, and in terms of it all particulars are explained or described. A few illustrations will clarify these statements.

The basic hypothesis of chemistry is that all forms of *matter* are composed of atoms. Atoms are considered the smallest and most unitary bits of matter in which the chemist is interested. He, therefore, explains all substances in terms of these units. Water, for example, is a combination of two units of hydrogen and one of oxygen. Every substance, from the standpoint of the chemist, is composed of a specific number of atoms of one kind combined with specific numbers of atoms of other kinds. Thus the chemist thinks in terms of his basic hypothesis.

Similarly, a basic hypothesis in genetics is that all living organisms originate as *genes*, or unitary structures or characters. These are found in the protoplasm of the cells from the male and female. When he makes this assumption, the geneticist attempts to account for the existence of all living tissues and their characteristics in terms of the genes.

Such assumptions as these are called hypotheses because there is possibility of error in them. Atoms, for example, may not be the simplest and most useful units of matter; and genes may not be the unitary structures in the germ cell. Moreover, none of these units is actually known to exist. They seem to exist, but their existence, in each case, is an inference based upon observed data. If future investigations reveal that such units do not exist, or that other units are more fundamental, each of the sciences will have to reconstruct its principles on a new hypothesis. (3)

The basic hypothesis of psychology is known as the *reaction hypothesis.* This will be discussed and explained later.

Theories

Description

A theory may be defined as an explanation, in terms of a given hypothesis, of known facts regarding any problem or process. When working with an hypothesis, a scientist, or group of scientists, may select a great many facts, data, or particular instances which appear to sustain or verify the hypothesis. Consequently, each particular fact is interpreted in terms of the hypothesis and may be used as an example of it. Moreover, an effort is made to regard in this manner any new facts or data brought to light by additional scientific observation. Thus when an extensive body of related facts is accumulated and explained in terms of a given hypothesis, such an explanation is called a *theory.*

Theories are proposed as explanations of processes or events that are not fully understood or about which there is insufficient evidence to support all of the claims or statements made by the theorist. The theorist presents what he believes to be the truth, or what he thinks would be the truth, if all of the facts or evidence were known. In any one science, therefore,

there may be one or more theories set forth by different thinkers to explain some one process. In psychology, for example, there are several theories which explain each of such processes as vision, audition, feeling, emotion, etc. Each of the entire sciences, in fact, may be considered as a theory because each science is built upon one or more basic assumptions. The best test of any theory is the number of facts that are accounted for by it. That is, one usually accepts the theory that accounts for the greatest number of facts or observed instances.

Limitations

Science in general consists of various theories because investigation has not been carried far enough to establish all hypotheses. For this reason science furnishes the practical man with nothing better than these forms of knowledge. The best that the practical man can do is to apply hypotheses and theories to his problems and observe the results. (6)

The Law of Parsimony

The general rule observed by scientists or thinkers in choosing hypotheses and theories is known as the *Law of Parsimony.* This law may be stated as follows: "*Of several rival hypotheses that have been stated regarding particular observations, choose the simplest.*" In attempting to follow this rule, scientists are constantly testing, retesting, and seeking to verify all hypotheses and theories. By doing so, they add many significant facts to the total amount of information and also rid themselves of faulty hypotheses and theories. Moreover, in their attempts to verify or to disprove a basic hypothesis, scientists may need to unify and systematize their materials. This is one reason why scientists are always in search of a single formula or hypothesis which will explain or include all known facts in the field. (6)

Laws, Principles, and Generalizations

Laws

A *law* is a verified statement regarding the relation which exists among certain observed events. If a scientist makes a series of observations and shows beyond a doubt that one

undergoing the processes of education. This individual, as we have seen, is usually designated as the *pupil.* By the "nature" of the pupil is meant certain inherited and acquired characteristics; by "mental life" is meant the conscious states or processes involved in making various adjustments; and by "behavior" is meant actions or conduct exhibited in the movements of muscles and secretions of the glands. Frequently mental or conscious processes are considered as an aspect or as a form of behavior. When we so consider them, we refer to mental states or processes as *subjective behavior* and to muscular and glandular activities as *objective behavior.* The educational psychologist is interested in collecting a body of information concerning the pupil that will be of special value and significance to the educator. Psychology, as we have seen, is not concerned primarily with the problems of teaching, but with a much wider field. Educational psychology, on the other hand, takes these problems as its special field of investigation and scope of work, and seeks to assist educators in outlining a program of education of which the pupil is the center.

Having marked off this special field of investigation, educational psychologists are constantly in search of hypotheses, theories, laws, and principles which describe pupil nature and behavior; and they are also in search of procedures and techniques whereby these may be established. In general, educational psychologists borrow the methods of investigation employed by psychologists. But in dealing with specific problems, the educational psychologist is confronted with the task of devising special procedures and techniques that will reveal the facts needed to solve them. Consequently, educational psychologists have evolved many special devices by which they have accumulated a considerable body of information worthy of the name scientific.

We shall at this point study the basic hypothesis employed in educational psychology and some of the methods of investigation by which information is collected.

The Reaction Hypothesis

Statement and Definition of Terms

The reaction hypothesis, as previously observed, is an assumption regarding the fundamental character or nature of

human behavior. It is, therefore, a basic hypothesis of psychology and of educational psychology. It is usually formulated as follows: *All forms of behavior, whether subjective or objective, are responses-to-stimuli*, or *All forms of behavior are reactions.* This formula is usually symbolized by the sign *S*——*R*, in which *S* stands for "stimulus," the "——" for a "connection," and *R* for "response." By *stimulus* is meant any external or internal force or event that affects the organism or individual; by *connection* is meant certain processes within the organism whereby a stimulus is made to bring about a response; and by *response* is meant the organism's activity occasioned by the stimulus, or more technically, any release of energy within or by the organism or any of its parts. The entire assumption implies that the various activities and functions of the human being are the effects (responses) of definite causes (stimuli).

A few examples of stimuli and responses will help to make the meaning of the reaction hypothesis clearer. Let *S* stand for stimulus and *R* for response, and imagine the following events:

S	*R*
1. Bright light	Contraction of pupil of eye
2. Pin prick of skin	Movement of limb pricked
3. Slight noise	Turning of the head
4. Question	Answer

Example 1 means that a bright light strikes the eye and the pupil of the eye gets smaller by contracting. The bright light is a stimulus, the contraction of the pupil is a response, and the mechanism by which the muscles of the pupil are made to contract is a connection. The connection is in reality a group of nerve structures which will be described later. Example 2 implies that a person who is pricked with a pin makes a sudden movement of the limb pricked. The pin prick is the stimulus, the movement is the response, and the connection includes the nerve structures which connect the skin with the muscles involved in the movement. A slight noise may cause the individual to move or to turn his head. The noise is the stimulus, and the turning of the head is the response. This is symbolized in Example 3. In like manner, a person who answers a question is responding to a stimulus, the question being the stimulus

and the answer the response. Thus, each activity performed by the human being is called a response, and the force or action which causes the activity is called a stimulus. (8)

Frequently the human being is responding to a number and variety of stimuli at one time. When this is the case, the stimulating forces or events are considered as a unit and are designated by the term *situation;* and the group of responses occasioned by a situation is called a *reaction.* Thus a *reaction* is a complex group of responses occurring at the same time. Sometimes the term "reaction" is used to describe a response-to-a-stimulus; that is, when we say that "human behavior consists of reactions," we employ the whole process—stimulus-connection-response. (6)

In terms of the reaction hypothesis, *environment* may be redefined as consisting of all of the forces and influences that serve as stimuli or situations; and *adjustment* may be described as the responses and reactions that the individual makes to the stimuli and situations afforded by the environment. It may be said, therefore, that one adjusts to environment, reacts to situations, and responds to stimuli. Adjustment is thus the final product of reacting and responding in particular ways.

Values and Uses of the Reaction Hypothesis

The reaction hypothesis, one may observe, is a very useful formula both from the scientific and the practical standpoint. From the scientific standpoint, it enables the psychologist to think of the organism as a sensitive structure that acts only when acted upon; and thus of specific instances of behavior as effects of definite causes. When the psychologist wishes to establish a law of behavior, he selects particular stimuli, presents them to his subject, and then determines by observation and measurement the kinds and extent of the responses made by the subject. Assuming that what he observes and measures are the effects of the stimuli that he has presented, the psychologist is able to state his conclusions in terms of cause and effect. Repetition of his observations will eventually enable him to arrive at laws and principles governing the reactions being studied. Then the psychologist can say, "If I present this stimulus, the organism will respond in this manner and to this

extent." In being able to discuss behavior in this manner, the psychologist has many points in common with all of the sciences. That is, his observations and studies, if carried far enough, will enable him to make valuable predictions. Moreover, by accepting a single formula by which to describe all forms of behavior, or every particular instance of behavior, the psychologist is able to unify and systematize his thinking and his findings. He finds it particularly valuable in building up a system of terms by which to describe behavior, each of which can be given fairly definite meaning.

From the practical standpoint, the reaction hypothesis has its chief values in education. One value here is that it has changed the educator's conception of his task. The older psychology, which emphasized the study of mental faculties, led the educator to think of his task as that of developing such faculties. The teacher, for example, was led to think of each school task as a kind of exercise intended to give the mind a particular type of discipline. School tasks combined were considered a set of mental gymnastics which would prepare the individual to deal with the problems of everyday life, whether these exercises were related to everyday life or not. The child needed to be trained and disciplined, and when he was trained, he could do efficiently any piece of work that he was called upon to do. From the standpoint of the reaction hypothesis, however, education is regarded as a very different process. It consists of a series of changes effected in the individual by assisting him to react properly to a variety of situations. The materials of education, selected from situations of everyday life, are the stimuli which the teacher presents; the child's responses are carefully controlled and directed until he reacts properly to these situations. It may be seen, then, that the teacher's task is not that of giving the child difficult mental exercise, but is that of confronting him with definite things to do, to know, to understand, to appreciate, etc. This view of education requires that the teacher consider the nature of the task which the child is called upon to accomplish, his fitness or preparation for reacting to it, the difficulties that he is likely to experience, the selection of desirable ways of reacting, and the elimination of undesirable ways. In doing this, his aim is not discipline but *adjustment* on the part of the pupil. (12)

Difficulties Involved in Using the Reaction Hypothesis

Though a relatively simple and useful formula, as we have just seen, the reaction hypothesis is not easy to apply to different instances of behavior. This is particularly the case when we seek to explain subjective, mental, or conscious events; that is, to apply the formula to thought processes. Suppose, for an example, that a given individual sees a friend. This friend is an external stimulus to which the individual may make any number of responses. He may call the friend's name, he may shake hands with him, or greet him in other ways, or the two may enter into a conversation. All of these are responses that may be observed as resulting from a given stimulus. But while these responses are taking place, a series of thought processes may be going on somewhat as follows: the sight of the friend calls up his name; his name calls up that of another friend; thinking of this other friend may call up a previous fishing trip; and the fishing trip may revive a part of the joy that was experienced on it. And in this way the process of thinking may go on indefinitely. When one behaves in this manner, it is difficult to describe any part of his behavior as stimulus or response. It is easy to see, of course, that the sight of the friend is a stimulus which initiates the thought process; but at what point does this stimulus cease? Moreover, is the thought of the friend's name a stimulus for the recall of the other friend? If so, it is likewise a response; and so is each successive event both a stimulus and a response. Then, in thought processes in which one thought revives another, what is "stimulus" and what is "response"? This is a difficult question to answer, except to say that a particular event may be either stimulus or response. It is a stimulus when it is the cause of another event, and it is a response when it is the effect of still another previous event. A thought process is thus a series of stimulus-response events in which one thought causes another.

How Mental States Are Included by the Reaction Hypothesis

Though mental processes are difficult to explain in terms of the reaction hypothesis, many psychologists prefer to consider them as responses to stimuli. This is done by assuming that behavior is psycho-physical; that is both psychical or mental and physical. This assumption implies that the individual may

respond in two ways to each stimulus; he may respond by being conscious of it, together with its qualities, meanings, etc.; and he may respond by making a movement or a series of movements; or he may respond in both ways at the same time. The first type of response is subjective, or mental; the second is objective, or muscular or glandular. In some instances, the subjective response is dominant; in others an objective response is dominant; in still others, both types of responses are present. For example, you may touch a hair on the back of a person's hand and try to observe the response. You may not be able to observe any response at all. Yet the individual can tell you that he did respond by becoming aware of a tickling sensation. The individual, however, may move when the hair is touched, and this response you could observe. The first response is subjective, mental, conscious, or psychical; the second is objective or muscular. If the individual becomes aware of the tickling sensation and moves also, he has made a combined, psychophysical response.

From this standpoint, man has been described as a psychophysical organism, an organism which has the capacity of responding either physically or mentally, or in both ways, to a given stimulus. In responding mentally, one response may serve as a stimulus for another, and this in turn as a stimulus for another, and so on, in the manner suggested above. Often the only way an investigator can know that the individual is responding subjectively is to ask him to speak, write, or move, or to tell what he is experiencing. These objective responses may then be used as a basis for inferring the nature of psychic processes. When a person is asked to describe his psychic processes, he is said to *introspect*.

In showing how a simple formula is applied to human behavior, we do not mean to simplify the behavior itself. Human behavior is, no doubt, the most complex type of thing the student is called upon to study and understand. It baffles the best and wisest of thinkers, even in its simplest forms. What the reaction hypothesis represents is a starting point for discussion and study of the behavior it is used to describe. As a matter of fact, the reaction hypothesis did not come into psychology without a struggle, and it continues to be criticized severely. Many psychologists still prefer to analyze mental

processes into sensations, and by introspection to account for objective forms of behavior as expressions of mental states. Our own point of view is that the reaction hypothesis is the most convenient and very likely the most accurate way of describing behavior. It will, therefore, be used throughout this text.

METHODS OF INVESTIGATION

Meaning

Types of Methods

By "methods of investigation" is meant the procedures and techniques employed in educational psychology as a means of collecting data and of establishing hypotheses, theories, laws, and principles regarding human behavior. Of these there are two types, *subjective* and *objective*. *Subjective observation* is a direct inspection of one's own mental processes. *Objective observation* is a study of the activities of an individual or group by someone other than the individual being observed. To the subjective type belong introspection and retrospection. To the objective type belong ordinary observation, questionnaire, statistical inquiry, tests and measurements, and experimentation.

We shall now try to describe each of the methods and indicate its advantages and disadvantages.

Introspection

General Description

This is the traditional method of psychology, and the one upon which early psychologists depended for the larger portion of their knowledge of mental life and activity. The word "introspection" means "to look within." Psychologists look within their minds, as it were, to discover how they think, reason, imagine, etc. As carried on by trained individuals, the method of introspection consists, therefore, of a direct, systematic process of self-observation, the nature of which is a study of one's own mental processes for the purpose of discovering facts regarding implicit or subjective behavior. Obviously, such a method is at the disposal of anyone who chooses to use it, and it is for this reason that the psychologist often requests un-

trained subjects or individuals to report by speech what is apparently going on in their minds. This type of introspection is called *verbal report*.

An Illustration of Introspection

Suppose one wishes to make an analysis of the reading process. He starts the observation by selecting a poem to read. He first notices the mechanical features of reading. He is aware that his eyes travel along the line of print. He notices that frequently his eyes go back over some portion of a line that he did not comprehend clearly. He is not aware of the letters, unless a word is misspelled, but he is aware of words and phrases and often notices only their meanings. He notices further that he perceives the words in their relation to each other rather than singly; that each word may get its particular meaning from the context rather than from the simple meaning he had attached to it when it occurred alone. He notices also that some words are accompanied by mental images of the objects they symbolize, and that they arouse images of sights, sounds, etc. Thus he continues, attempting to give an account of the reading process. If he wishes to secure similar information from other individuals, he may ask them to report to him the nature of their reading. He may ask them to answer a list of questions regarding their reading habits. They will be able to answer these questions only by studying their experiences as he has studied his. By combining the individual reports in a systematic manner, one may accumulate a body of usable information.

Criticisms of Introspection

Although it was once regarded as a scientific method, introspection has lost most of its original prestige, and it is now being criticized by many thinkers. The chief criticisms made of it as a method of investigation may be summarized as follows: (a) While introspecting, the attention of the observer is divided, as he is obliged to give attention, at the same time, to the mental operation which he is studying and to the process of introspection. Since it is impossible to give adequate attention to two things at once, introspection is really *retrospection*, an observation of a process that is past or passing from the observer. It is

claimed, therefore, that one cannot introspect a mental process, since he must depend upon his memory, and memory is unreliable. (b) The act of observing a state of mind or mental process tends to change or modify the state or process itself, and thus introspection tends to interfere with its own purpose. (c) Mental states or processes change so rapidly that only the slower changes can be observed. It may be seen, therefore, that as a method, introspection never furnishes a complete account of the mental operation. (d) Not all individuals about whom information is desired are able to make introspections. Animals, children, defectives, and insane persons cannot introspect. Thus the method is applicable only to the study of normal or superior adults. (e) The method of introspection does conform to the scientific program of verification. Scientific observations are of the variety that can be repeated and checked by other investigators. The data of introspection cannot be verified by repetition, since the mental operations of different individuals are never alike. In fact, introspection deals with unique processes. They are never the same in a given individual on different occasions, nor are they the same in different individuals on the same occasion. (12)

Values of Introspection

Though introspection is criticized in this manner, it will continue to function significantly in all psychological investigation. The reasons why it will continue to be used may be stated as follows: (a) It is the only method by which some events can be observed and studied. (b) When it has been used by trained observers, it has contributed much to our present knowledge of psychological processes. (c) By introspection, one interprets, verifies, accepts, and rejects even the findings of carefully controlled observations. He does this consciously or unconsciously by projecting himself into the situations which the observer describes. (d) Introspection is often valuable in discovering and formulating new problems. (e) By introspection one interprets and enlivens the facts, laws, and principles brought to light by objective methods.

It should be pointed out, however, that introspection and retrospection should rarely be relied upon completely to throw light on psychological processes. As a rule, they should be sup-

ported by those more objective methods of observation which will now be described. (1)

Casual Observation

Nature of the Method

The *casual observation* may be described as the effort to employ ordinary observations and judgments for practical or scientific purposes. Schoolmen, administrators, and teachers are constantly revising and reshaping their procedures, methods, materials, and discipline in order to get better results from their labors. They base their revisions on their observations of changing conditions about and within the school. They may observe, for example, the changes in society, the lack of improvement in their pupils, the failure of disciplinary measures, etc., and set themselves the task of improving their procedures. Many desirable changes have been made in the schools as a result of discoveries arising from casual observation. Frequently, however, such observations are useless and lead to erroneous conclusions and practices. (10)

Unreliability of Casual Observation

As a scientific method, casual observation is unreliable, in psychology, even when employed by those who have mastered the art of observing their fellows. In the first place, the method is subject to many of the criticisms made of introspection. In observing the behavior of an individual or group, the observer must keep his problems in mind, note the various factors that influence the subjects and the details of their behavior, and formulate an opinion or conclusion with regard to the nature, amount, and efficiency of the behavior. All of this, of course, cannot be done simultaneously. As stated above, an observer can attend only one thing at a time, and while he is observing one series of events, another equally as important may be occurring. Thus, personal impressions gained from observing human behavior are likely to be hazy, indefinite, and inaccurate. Men of science recognize the fact that many important discoveries have been made by ordinary observation, but because of the possible inaccuracies inherent in the method, they are doubtful of its results and conclusions. They have, therefore, set them-

selves the task of devising more accurate and dependable methods of investigation.

The Questionnaire Method

Description

The questionnaire consists of a series of carefully formulated questions given to a large number of persons about some particular question or problem. One of the first questionnaires used in psychological research was formulated by Galton in 1874 as a means of studying "mental imagery." Galton instructed his subjects as follows: "Before addressing yourself to any of the questions on the opposite page, think of some definite object—suppose it is your breakfast table as you sat down to it this morning—and consider carefully the picture that rises before your mind's eye. Questions: (a) Is the image dim or fairly clear? (b) Are all of the objects well defined at the same time, or is the placc of sharpest definition at any one moment more contracted than it is in a real scene? (c) Are the colors of the china, of the toast, bread-crust, mustard, meat, parsley, or whatever may have been on the table, quite distinct and natural?" These are only a few of the questions asked the subjects. Upon receiving the answers, the investigator arranged them to show the number of persons reporting no images, very intense images, faint images, etc. By doing this he was able to give his data a *quantitative* treatment; that is, to state his findings in terms of quantities. He was able to find, for example, the relative number of images experienced by persons of different occupations and trades. He could also have treated his data statistically—the finding of averages, deviations from the averages, amount of correspondence in imagery in different types of persons, etc.

Advantages and Disadvantages

The questionnaire method of collecting information is of particular value because it enables the investigator to state his findings in terms of quantities or definite amounts. It is specially valuable in getting a measure of varied interests, opinions, likes and dislikes, and prevalent practices in different schools. If not carefully used, however, the questionnaire method will possess many shortcomings and disadvantages. Many times, for

example, the subjects answering the questions are careless or untruthful; some may be prejudiced or biased in particular ways; others may not understand the nature of the task or the meaning of the questions, and thus guess at the answers or put down answers without careful thinking. Used judiciously and carefully, however, the method yields some valuable information that is very difficult to obtain by any other method. It provides a record of the individual's reactions to the questions, and furnishes a basis for quantitative treatment of the results. (9)

Tests and Measurements

General Description

Tests are devices consisting of performances, questions, problems, and exercises of varied character designed to measure human abilities. The student is familiar with the tests or quizzes and examinations used by teachers to measure the amount of information gained by pupils in a particular subject or course. These are not the tests now under consideration. We are thinking here of the so-called *standardized* tests designed to measure the simple as well as the complex mental processes, such as memory, association, general information, and numerous other traits and abilities. Some tests are designed to be given to individuals, others to groups and classes of moderate size. The main purpose of a test is to measure the amount of difference between individuals. Great care is exercised in making tests in order to be certain that they will measure the trait or ability they are intended to measure. If they do this, they are said to be *valid*, and various devices are used to establish their validity. Many tests which are now used as regular measures of different abilities have been *standardized* by giving them to hundreds, or even thousands, of individuals representing a particular group, and by finding the average score or *norm* for a particular age or grade. A standardized test makes it possible to determine the ability of an individual or group by comparing the results in a given instance with the norms.

Types of Standardized Tests

Various types of standardized tests are now in use. The most familiar of these are the *mental* or *intelligence tests*, designed to

measure native capacities, and *achievement* or *educational* tests which measure abilities in the various school subjects, such as reading, spelling, arithmetic, and geography. There are several forms of each of these general types of tests but these forms will not be discussed here. Another group of tests includes measures of aptitudes for different vocations, musical ability, temperament, emotional traits, and personality. And yet another group measures physical traits and abilities. In this group are such tests as measure height, size of various parts of the body, and such abilities as muscular steadiness and precision, and strength and speed of muscular contraction. (For a more detailed discussion, see Part IV.)

ADVANTAGES AND DISADVANTAGES. In making tests of various kinds psychologists have added to the materials which are of interest to the educator. Standardized tests are now used as practical devices by the best schools for such purposes as classifying and sectionizing pupils according to their abilities. Tests are also used as tools in research. As such, they are truly objective measures, and are free of the weaknesses and disadvantages of the questionnaire and introspective methods. Tests constitute one of the most important means of approaching numerous problems of interest to the psychologist in his efforts to accumulate materials for the benefit of educators. The chief weakness of tests as tools for research lies in their failure to make possible an analysis of the traits and processes whose amounts they measure. For example, a reading test may measure the individual's speed and power of comprehension, but it does not reveal the individual's method of reading, nor the difficulties which he experiences. As measures of amounts of abilities, tests contribute richly to our knowledge of human beings, and give us much information concerning educational practices and procedures.

Statistical Method

Nature of the Method

The statistical method is the collecting and arranging of data already in available form and essentially ready for use. One might collect statistics or figures, for example, to show the effect of attendance on grades, the extent of passing and failing

in a school or college, the relation of high school standing to success in college; and various other facts of practical or scientific value. In order to do this, the investigator would need only to go to the places where records of the data needed are kept, and arrange them according to the requirements of his problem. The reliability of the statistical method depends, of course, upon the reliability and validity of the figures accumulated. If the figures or measures are faulty, the conclusions based on them are also faulty.

The statistical method of investigation should not be confused with the statistical treatment of data. The latter refers to the mathematical operations required to find averages and deviations from averages, to the finding of correlation or amount of correspondence between sets of data, and to the making of charts, diagrams, etc., for the clear presentation of data in a discussion. Every investigator, in dealing with large bodies of data, such as those obtained by the questionnaire, experimental, or statistical method of inquiry, should give them rigid and exact statistical treatment as a method of showing general trends, and of testing the reliability of averages or other measures of central tendency. (6)

Experiment

Description

In general, any type of investigation carried on under prescribed conditions, for the purpose of collecting information concerning a certain problem, is an experiment. In strict scientific usage, however, an experiment is a type of controlled observation definitely arranged to produce events at a certain time and place, and under such conditions that they can be recorded, measured, and analyzed at leisure, for the purpose of solving a certain problem. When using observation as a method of investigation, the observer has to wait until the events he wishes to study are in operation or are completed. When using experimentation the observer prearranges the conditions so that a certain activity or process can be recorded and measured at the time it is in progress. The main purpose of an experiment is to secure data that are definite, precise, accurate, and capable of being checked or verified by various investigators. Experi-

ments are thus a part of the main program of all science. Though once used only in the physical sciences, experiments have made their way into the biological sciences, and now are the recognized method of science in general. (10)

Types of Experiments

Two types of experiments have been used extensively in the field of educational psychology. These are: (a) the method of parallel groups, and (b) the laboratory method. The first is of value in studying the performance of groups and individual differences, or in obtaining information regarding problems which arise in dealing with groups. The second is of value in studying the physical and mental processes involved in the performances of individuals.

Parallel Group Method

PROBLEMS INVOLVED IN USING THE METHOD. The chief problem involved in the use of the parallel group method is that of equating two or more groups of subjects in all essential respects except one, and of measuring and describing the effects of this one factor on the performance of each group. For example, a study of the effects of quizzes on pupil achievement in two equated groups in history would require teaching one group of pupils without using quizzes, and another with quizzes at stated intervals, and then finding the differences between the two groups on a final examination. This procedure would test the effect of the quizzes, however, only when the two groups were approximately equal in their previous knowledge of history, in their ability to learn history, in intelligence, etc., and when the teaching and learning conditions were the same for each group. Thus the investigator would have to select his two groups on the basis of suitable tests, and make them as nearly equal as possible. Then he would have to see that they were taught in exactly the same manner, except for the quizzes. He would also have to give the same materials, same assignments, make the study opportunities and the time used in study the same, and also see that all other factors which might influence the results were either equated or controlled. At the end of the teaching period he would give the same examination to each group and note the difference in the performances of the two

groups. He should also describe his procedure carefully, and explain the method of treating the results, so that other investigators would be able to repeat the experiment and thus verify or refute his data and conclusions.

ADVANTAGES AND DISADVANTAGES. There are several ways in which a group experiment may be conducted, but the above example will indicate the outstanding features of the method. If it is used with great care, especially in controlling all variable factors, the method is capable of yielding fairly reliable results. It, likewise, has the advantage of being applicable to classroom conditions where the merits of numerous procedures, teaching methods, and devices can be tested in actual classroom situations. The chief disadvantages of the method arise in connection with the difficulties involved in controlling all variable factors. It is almost impossible to select two groups of people equal in every respect, or to make experimental conditions the same in each group over a long period of time. It may thus be seen, then, that such experiments should be repeated a number of times with various groups before the reliability of the conclusions is assumed. (9)

The Laboratory Method

GENERAL CHARACTER OF THE LABORATORY METHOD. This method of experimentation involves the use of apparatus .that will enable the investigator to secure accurate, permanent records of a particular performance. The instruments employed are usually designed to record and measure the amount of time, the extent or amount of performance, and, as far as possible, its nature. It is impossible, of course, to secure records of mental processes. but it is not very difficult to secure records of muscular, glandular, and speech activities, and these often enable the investigator to *infer* the nature of the mental process. Mental processes, it will be recalled, can be observed directly by introspection. The emphasis in laboratory studies, as far as recording is concerned, is on the motor activities involved in a particular process.

AN ILLUSTRATION OF THE USE OF THE LABORATORY TECHNIQUE. As an illustration of the laboratory method, attention may be called to the technique used in the study of reading. This technique involves the use of an apparatus known as the

eye-movement camera. This is an instrument which enables a beam of light to be reflected, first from mirrors to the cornea of the eye, and then from the eye through a photographic lens to a focus on a moving film. The object or purpose of the apparatus is to get a record of the horizontal movements of the eyes as they move along the line of print in reading. As long as the eyes are stationary the film record is a straight line, but with the eyes in motion the record shifts from left to right with the eyes. Thus, as the reader moves his eyes along the line of print, a record is made on the film which shows the stops or pauses, backward movements, the sweep from the end of a line to the beginning of the next, and many of the characteristics of such movements. If a vibrating tuning fork is placed in the beam of light so as to interrupt it at each vibration, the film record becomes a series of dots instead of a continuous line, and each dot represents an amount of time equal to a vibration of the fork. Thus the record makes it easy for the investigator to determine the number, location, and length of the various pauses and backward movements. Since the reader is normally unaware of the manner in which he moves his eyes, the records of their movements make possible a fairly accurate analysis of his habits of methods of reading, and furnishes a basis for inference, regarding the nature of the mental processes involved in reading. In fact, much of our present knowledge of reading is based on studies made with the aid of the eye-movement camera.

Problems Involved in Using Laboratory Method. The eye-movement camera is only one of several instruments used in the study and analysis of human performances. A well-equipped laboratory for educational psychology includes a large variety of apparatus designed to measure and record other kinds of processes than reading. These measuring and recording devices have accumulated as a result of the efforts of research workers to devise ways and means of studying various problems. In fact, when any student of behavior approaches the study of a problem for which no piece of apparatus is available, he is confronted with the task of making one that will yield the kind of data he wishes to obtain. In using apparatus, the investigator is likewise confronted with the task of controlling all factors which might conceivably influence the performance of

his subjects. He must be certain that his records are accurate measures of the performance, and that his data are related to the problem being investigated. When such controls are obtained, the laboratory method reaches the peak of scientific efficiency in the study of human behavior. (9)

Schools of Psychology

The controversy over introspection has resulted in the division of psychologists, generally, into two schools usually designated as *mentalists* and *behaviorists*. *Mentalists* are psychologists who stress psychology as the study of mental states and processes and who believe in the use of introspection and retrospection as valid methods of observation. *Behaviorists*, on the other hand, are psychologists who restrict psychology to the study of behavior, muscular and glandular activity, and who stress the use of objective methods of observation. The refusal of behaviorists to study mental states and processes is based largely on the inaccuracies of introspection and retrospection and the consequent confusion among mentalists as to the nature of mind, mental life, mental states, etc. If such things or activities exist or occur, the behaviorists say, we can never know their exact nature, because we have no method of observing them that will yield accurate or scientific information. Some of the strictest behaviorists assert that we may as well discard such terms and notions and concentrate attention on those aspects of human life about which we can secure accurate information. These aspects, of course, are the observable acts of behavior that can be studied objectively, the objective features of behavior described above.

Without becoming involved in this controversy between the mentalists and behaviorists, it is sufficient to say here that "there is much to be said on both sides." Our own point of view is that the beginning student should study available materials related to both types of behavior. If the beginner becomes a mentalist or a behaviorist, he should do so as a result of his own thinking, after he has considered the materials presented by both groups of psychologists. To this end, we shall ignore the controversy throughout this text and emphasize ideas which, in our judgment, the beginning student should know.

EXERCISES

1. What are the main characteristics of science as knowledge?
2. Why do all sciences include ideas the bases of which are uncertain? Discuss.
3. Show how a scientist proceeds in the investigation of a problem. Why does he proceed in this manner?
4. Define and illustrate the following terms: opinion, belief, hypothesis, theory, law, generalization, and principle. Of what value to the scientist is each of these types of knowledge?
5. Note the distinction between specific and basic hypotheses, and discuss the need of each in scientific investigations and in dealing with practical problems.
6. What use do scientists make of the Law of Parsimony? Show how this law can be applied to problems of everyday life.
7. How does the educational psychologist differ from the psychologist? In what subject matter is each particularly interested?
8. Give the meaning and use of each of the following: (1) reaction hypothesis, (2) stimulus, (3) connector, (4) response, (5) situation, (6) reaction, (7) environment, and (8) adjustment.
9. What are the values of the reaction hypothesis from (a) the scientific and (b) the practical standpoint?
10. What are the chief difficulties involved in using the reaction hypothesis? In what ways are these overcome?
11. Indicate the nature, advantages, and disadvantages of each of the methods of investigation described.
12. Characterize the two schools of psychology and psychologists. Should educators adopt one viewpoint or the other? Why?

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PART II

ENVIRONMENT AND HEREDITY

Purpose of Part II

General Problems

We now begin the study of the materials that constitute the science of educational psychology. Our first problem is to get acquainted with the forces and influences that constitute the environment to which the human being must adjust, and with the equipment that he uses in making the adjustment. This equipment is composed of the structures, functions, and capacities that the individual inherits from his parents and previous ancestry. Our second problem is to study the growth and development of these hereditary traits, and to discover the manner in which the individual employs them in adjusting to different aspects of the environment.

Specific Problems

Such questions as the following may enable the student to grasp the nature of these problems: (a) What are the different forces of the environment that affect the human being, and in what ways do they affect him? (b) With what structures or organs is the individual equipped that make adjustment possible? (c) How do these structures function? (d) What are the factors that determine the growth, development, and maturation of structures? (e) How do these processes affect the behavior and capacities of the individual? (f) What traits and patterns of behavior appear and develop as a result of these processes? (g) How are these traits and patterns modified by experience and training?

Plan of Discussion

Several chapters will be devoted to a discussion of these problems. In fact, a separate chapter will be concerned with each of them. In these chapters, an effort will be made not

only to set forth various facts, hypotheses, laws, and principles, but also to acquaint the student with many new terms. The student should study each term carefully; note how it is used in this text; compare its meaning here with that in other textbooks in the field; and in this way build up a vocabulary with which to discuss psychological problems.

CHAPTER III

NATURE AND CHARACTERISTICS OF ENVIRONMENT AND HEREDITY

INTRODUCTION

Definitions of Terms

Environment

The term environment, as previously employed in a number of instances, is used to describe, in the aggregate, all of the extrinsic (external) forces, influences, and conditions, which affect the life, nature, behavior, and the growth, development, and maturation of living organisms. A description or even mention of all these factors would require a treatise containing many chapters from each of numerous sciences; for man is affected in very definite ways by nearly everything that surrounds him. And man, in turn, changes and modifies those things that affect him. Nevertheless, in the section that follows, an effort will be made to set out some of the main factors comprehended by the term.

Heredity

The term *heredity* conveys two meanings: (a) It is used to describe the transmission through the germ plasm of human cells from which individual life comes, of factors or genes which determine one's physical structures and many of his characteristics, many of his specific functions, and many of his abilities or capacities. These factors determine, in fact, the resemblances of offspring to parents or other ancestors. (b) It is used to refer to the sum total of traits or characteristics transmitted through the germ plasm. From this standpoint one's heredity consists of all the structures, physical characteristics, functions, or capacities derived from parents, other ancestry, or species.

By *structure* is meant either the various parts of organs that compose the human body, or the arrangement of the materials,

tissues, and parts of a particular organ. By *function* is meant the operation or activity that a given organ performs or is designed to perform. By *capacity* is meant the ability or power of a particular organ, or of the entire organism, to perform a particular function at a given rate or to a certain extent. For instance, the human eye is a structure designed to perform the function of seeing; and the individual possesses the capacity to see in either a normal or an abnormal amount, according to the condition or arrangement of the parts of the eye.

Since the human being is affected in various ways by environment, both environmental and hereditary factors operate in determining what he is and does. Some traits or characteristics are due wholly or largely to environmental factors; others are due wholly or largely to hereditary factors. Still others are due to the interaction of both groups of factors. Traits that are due wholly or largely to hereditary factors are designated by such adjectives as "inherited," "instinctive," "inborn," "innate," "native," and "original." Some authors use one term, some another; we shall use the terms as synonyms of each other. Any trait (physical characteristic, function, or capacity) is native to the individual if it appears in him by transmission or apart from the influence of environment.

After the discussion of environment, an effort will be made to show how hereditary factors operate in determining particular traits.

NATURE OF ENVIRONMENT

We may study environment by noting, first, the physical forces that affect man; and second, the social influences that play upon him.

Physical Environment

By "physical environment" we mean (a) the physical features of the earth and its neighbors, and (b) the physical forces that affect man's specialized sensitive structures.

The Earth's Neighbors

The "earth's neighbors" comprise the stars, the planets, and the sun and moon. Through a study of these, by means of the instruments of astronomy, we get an idea of the earth in its

relation to other bodies in space. Too, we come to understand the earth's varied conditions of life, its climates and seasons, its energy from the sun by which all life is made possible, its wide range in atmosphere, surface, water, soil, etc. And we come to understand, through other sciences, the importance and significance of all these for man.

Through a study of mythology and religion, we come to understand how the earth's neighbors have affected man's conduct. Through his ignorance of the universe of space and of the occupants thereof, man has told many of the great stories that have become his patterns of conduct. Worshipping the unknown and the mysterious, he has set up influences within his own structures that often determine not only his behavior patterns but also his convictions regarding his eternal destiny. Though now enlightened regarding the meaning and significance of his neighbors, man still has much to learn and is still influenced in these vital ways by the uncharted mysteries of his universe. (4)

Geologic Features of the Earth

The rocks and soil of the earth have and will continue to have great influence on the life of man. Geologic records in the strata of the earth's crust tell the story of very simple kinds of living things that existed upon the earth previous to man. As the strata are followed upward to the more recent deposits, there is in the fossils a record of constant changes in life and in the characteristics of plants and animals. Biological geography, devoted to the study of these changes, shows how plants and animals have varied as a result of the varying conditions in the substances and climates upon which they have been forced to depend. Historical biology adds another chapter to the story by describing the numerous adjustments made by plants and animals to the changes effected in rock and soil. It shows, for instance, that a given generation of a particular species under changed conditions became very different from the specimens that remained under the old conditions. That is, the plants and animals which were surrounded by new conditions were subjected to changes in external characteristics and in internal structures, so that they eventually took on new appearances and new modes of life and action. The cactus plant of the desert, for example, as well as its kindred flora, and even many forms of ani-

mal life, are apparently the products of ages of struggle with the peculiar conditions of soil and climate in such regions. (4)

Effects of Physical Environment upon Man

How much or how far man has been changed by the factors of his physical environment, in his structural and external characteristics, is not known, but it is known that these factors have had a marked influence on many structural and behavior characteristics. Like plants and animals, man is found to vary considerably, in many important respects, in accordance with the localities in which he lives and with the geological and geographical features of these localities.

We are not interested primarily at this point in what man *was* structurally, but in what he *is* and in how he is most significantly affected by his surroundings. Structurally, man for many ages seems to have been much as he is now, but socially and economically he is very different now from what he was even a few centuries ago. Historians and geographers have well described the major differences between peoples of different countries, and have attempted to show which of these differences are due to the climatic and surface features of various localities. They show us that even though the fundamental needs of life, such as food, oxygen, water, and favorable temperature and pressure, are present in different localities, variations within these factors help to determine whether one is a dreamer, a doer, an idler, a producer, a savage, or a progressive citizen. What would have been the history of civilization had the earth been encompassed by the sweltering heat of Africa, or the biting cold of Alaska? What would have been the social and economic, not to mention the cultural, life of peoples of today had it not been for the nature of the coastlines and mountains of Greece, the seven hills of Rome, the water-bound coasts of England, the mountains of northern Italy, or the isolated and fertile fields of America? So profoundly have different races been affected by their geological surroundings that they often seem to have few characteristics in common. (4)

Physical Forces and Sensitive Equipment

Though man is affected in vital ways by the earth's neighbors and by the geological and geographical features of the earth,

he is more directly affected by those forces that act upon the sense organs, such as the eyes, ears, and skin. Equipped with these sensitive structures, man is capable of making specific responses to such forces as light waves, heat waves, sound waves, and various other forces that serve as stimuli. These specific responses, in turn, are organized into definite patterns and systems of behavior in accordance with the patterns in which the stimuli are presented. From the standpoint of education, these sense avenues constitute the direct approach by which environment, whatever its other factors or forces, is presented to the reaction equipment of man. That is, what man does in any physical environment is determined most directly and effectively by the presentation to his sense organs of the stimuli that may be selected by his social agencies or agents. These forces, more than any others, are therefore, of greatest concern to the psychologist and to the student of psychology.

Social Environment

Man a Social Creature

In the complex structures with which man reacts to his environment, by making specific responses to definite stimuli, we find a basis of living that enables man to adjust on a much higher level than that of any other living creature. It is this special equipment that gives man the ability to know and comprehend his world, to communicate and co-operate with others, and to alter his environment to meet his own needs and desires. Man's ability to hear, to speak, and to evolve a language, for example, gives him the ability to communicate with others, and in the exercise of his ability, he becomes the only social creature upon the earth. Moreover, in his struggle for food, water, shelter, and other fundamental necessities, and in coming in contact with others engaged in the same enterprises, man has become slowly a social creature and evolved a *social environment.* (7)

Nature of the Social Environment

The term "social environment" implies two types of institutions which men have evolved through co-operative effort. The

first of these types is often designated by the term *social heritage*, and the second by the term *human society*.

By *social heritage* is meant a large number of institutions which, from the beginnings of history, have been passed on from generation to generation for the benefit of each newly-born individual. These institutions include: (a) language, writing, printing, printed literature, science, art, music, and architecture, by and through which men have perpetuated their knowledge and artistic skills; (b) moral and ethical codes, customs, conventions, laws, religions, and governments, in which men have formulated and made permanent their prejudices, ideals, hopes, and aspirations; (c) devices for transportation and communication, money, conveniences and luxuries, and handicrafts, by which men have carried on business and commerce and given expression to technical skill; (d) professions, trades, industries, vocations, and the like, by which men have marked off their different divisions of labor; and (e) numerous other institutions in which men have registered social gains, creations, and enterprizes. All of these institutions, in fact, represent the ways in which men, through co-operative effort, have crystallized their life's experiences and set them in order for the coming generations. This is why we speak of these things as our *social heritage*. It is an heritage that each individual, upon arriving in the world at birth, finds ready for his use and convenience. (7)

By *human society* is meant the institutions which men have evolved for the purpose of preserving the life of the individual and of imposing upon him the social heritage. These institutions include: (a) the home; (b) the school; (c) the church; (d) the community, including local, state, and national organizations; and (e) a host of "societies," clubs, and fraternal organizations. As far as the behavior of the individual is concerned, these represent the most important factors of the social environment. In these, men have reached a stage in their social evolution where they aggressively impose all other institutions upon the individual and force him to adjust to a sufficient number of them to survive and to find expression for his desires and inclinations. These institutions exist, in fact, not only to preserve the individual's life but also to insure a transformation of the individual into a person who is willing

and able to conform to the social pattern of thought and action. If the individual tries to rebel or to modify this environment to suit his own wants, his efforts are never far-reaching, and in general, they are doomed to failure. Once accepted by society as a whole, all institutions are fairly permanent. They are difficult to change or modify, even when modification is sought by a large number of different individuals. The individual, alone, is just a transient member of the present generation, who must be modified and changed to meet the persistent demands of society as a whole. Thus, the main adaptations of life are not those involved in adjusting to the physical environment described above, nor even with the problems of existence, but with the acquisition of skills, knowledge, and modes of conduct which will meet the requirements of society as a whole. That is, the problem of the individual, other than that of self-preservation, is that of learning to avoid or inhibit that which fails to meet the approval of society, and to do, to say, and even to think that which agrees with the social pattern. (7)

Now that we have studied the general nature of *environment*, let us turn to a consideration of *heredity*. In the foregoing paragraphs, we find the type of factors which influence the individual; our next problem is to discover his possibilities of reactions.

MEANING AND NATURE OF HEREDITY

General Nature of Heredity

In speaking of heredity, we are referring to the process in living organisms of passing on to their offspring, biologically, their own traits. This process goes on as a means of perpetuating life upon the earth, and of preserving the fundamental traits of each species. The tendency of the species, race, and ancestry to preserve itself, through the medium of parents, is a universal law. This law is expressed in older terminology in such expressions as: "Like begets like," and "Let everything produce after its kind." So unswerving and invariable is this tendency that every individual is indelibly impressed with the traits of the species, of the race, and of the lineage from which he springs, as well as with those of his immediate parents. Moreover, the tendency is so well regulated that human beings can never

produce anything but human beings. Modern biology, it is true, has discovered some minor variations from this general tendency, but these are strikingly unimportant when considered in the light of the whole. Thus heredity conserves the species, determines the races, and some of their different characteristics, and conserves many resemblances and minor differences among individuals of the same family and lineage. (12)

The Mechanism of Heredity

Factors of Inheritance

Perhaps the clearest understanding of heredity, of its nature and laws, results from a study of human life at its beginning.

Every human being, as well as any other living creature, begins life as a single cell, known as the *zygote.* This cell is the result of the union or fusion of two cells; one from the father, known as the *spermatozoon* or *sperm*, and one from the mother called the *ovum* or *egg.* The sperm consists of a head, neck, and tail, and possesses the power of sweeping the tail back and forth in a wave-like movement which drives the body forward. The sperm usually lies dormant in the testicles where it is formed and carried about in seminal fluid. The ovum is found in the ovary, from which it is liberated at intervals of somewhat irregular length. It first makes its way from the ovary into the open end of the fallopian tube, and from there through the nearly-closed end into the uterus or womb. Here, if not affected by the sperm, the ovum undergoes certain changes and finally perishes. If the sperm is present during the passage of the ovum through the fallopian tube, or while it is in the womb, it may penetrate the ovum and fuse with it, producing the zygote. The process of fusion is called *fertilization.* After this process is completed, the zygote attaches to the placenta and from this receives nourishment from the blood stream of the mother. Here, protected from practically all external influences, the zygote becomes a human *fetus* and eventually a newborn *infant.* (12)

Carriers of Hereditary Traits

What the individual is to be, as far as heredity is concerned, is determined at the moment of fertilization. In the sperm

and ovum are unitary characters called *genes*, which constitute the carriers or determiners of particular traits. There is a gene, or group of genes, for example, which determines hair color, others which determine the size or shape of the fingers, others the texture of the skin, others the shape of the teeth, etc. There is a gene, or group of genes, in fact, to determine each of the inherited traits that the individual will ever possess. It is believed, in fact, that both structural and functional traits, as well as various capacities are predetermined by the genes. If this is true, it is easy to see why all inherited traits, which the individual will later exhibit, are potentially present in the zygote. (6)

The Operation of the Genes

How the genes operate in determining particular traits is one of the chief mysteries of biology. As a matter of fact, genes and their manner of operation are hypothetical. We do not know for certain that such entities exist. We do know, however, that there is something present in the human life-producing cells that determines in advance, to a large extent, what the individual will be. This something, in terms of individual traits, is all that is meant by genes.

Observation discloses that children of particular parents do not possess the same traits as the parents. This fact implies that the traits of the offspring are not wholly determined by the parents. This is possible because the parents are not producers or manufacturers of the genes, but carriers only. The genes, even the sperm and ovum, in fact, are creations or products of the species. These elements of heredity are parts of each individual's native equipment, just as any other particular structure or substance is a part of his or her native equipment. This fact implies that Nature takes care of reproduction and inheritance of traits without depending altogether upon any given pair of individuals.

Inherited equipment consists, therefore, of all the traits present in potential form in the zygote or fertilized egg, and that later appear in different stages in life in observable form as characteristics of the individual. No trait in an individual is considered a part of one's inherited nature or equipment unless it appears as a product of the genes.

HOW TO IDENTIFY INHERITED TRAITS

The Problem

While the question of the relative importance of heredity and environment cannot be determined, it is frequently important to know whether a particular trait is inherited or acquired. This problem is of some significance to educators, for they need to know where their work begins. If a trait is inherited, there is no need to trouble oneself about trying to make it appear, for it will appear apart from the influence of training or education; but if a particular trait is acquired, one can take steps toward making it appear or disappear. How to determine the traits which are inherited and acquired, however, is not an easy problem to solve; for both types of traits may appear at different stages in life, as well as at or near the same time. Frequently, too, some traits are a joint product of both factors. That is, the individual is partly a product of the unfolding of hereditary potentialities and predispositions, partly a product of environmental factors acting alone, and partly a product of the interaction of both groups of factors. (5)

Methods of Determining Hereditary Traits

In seeking to determine whether particular traits are inherited, psychologists usually depend upon methods and devices, or data, that will answer the following questions: (a) Does this trait or group of traits appear in the individual apart from the influence of environmental factors? (b) Does this trait or group of traits appear in different individuals who have the same heredity but different environments? (c) Does this trait appear in different individuals in connection with, or as a result of, structural growth? (d) Does this trait appear in all individuals belonging to a particular family group, race, or species? (e) Does the amount of this trait, or group of traits, remain the same after it has reached maturity? If each or any of these questions can be answered in the affirmative, the trait or traits under consideration are usually considered inherited. Whether one can be certain of the reliability of the answer one is able to give, however, depends on the nature of the trait, the reliability of the method of securing the data, and upon the extent of the sampling or the number of cases con-

sidered. How each question is answered in practical procedure may be illustrated. (5)

Appearance at Birth

Whether a trait appears apart from the influence of environmental factors is usually determined by observing infants and discovering traits that they possess. If a trait appears at birth, it is usually assumed to be inherited. The basis of the assumption is the fact that the environment has not had an opportunity to affect the infant in many vital ways, and that the infant, in turn, has not had an opportunity to learn very much, if anything. In making this assumption, one has to assume also that the human fetus is normally uninfluenced by environmental factors. This second assumption is unsafe, in the absolute sense, for the fetus is affected by environment in a variety of ways, as we shall see later; but as working hypotheses, both assumptions are very useful ones. At least, for practical purposes, we may assume that traits which appear at birth and during the early stages of infancy are, for the most part, inherited or native. Most of the traits that we consider inherited have been isolated and determined by this method and criterion.

Study of Resemblances

In order to determine what traits appear in individuals who have the same heredity, studies are often made of individuals of the same family group, particularly of twins, to discover to what extent they are alike. Such studies usually involve the making of measures and calculating the degree of correlation between the measures. If the members of a given family are subjected to radically different environments, or amounts of training, and still exhibit striking likenesses in the amount of particular traits or in the manner of performing given functions, there is some basis, at least, for assuming that the traits being studied are hereditary. This is particularly the case if identical twins are used as subjects or objects of study, for twins have the same heredity. *Identical* twins are of the same sex, usually very similar in appearance; and they are thought to arise from the same germ cell. *Fraternal* twins may be of the same or different sex, but they bear no more resemblance to each other than other brothers and sisters. If identical twins are sub-

jected to different environments, the extent to which they remain alike suggests the operation of inherited factors. Many studies of this character have been reported. (6)

Structural Growth and Maturation

One of the most useful methods of determining inherited traits is to discover the capacities and functions that appear at different stages in life regardless of variations in environment. It is certain that a growing child exhibits traits at various stages which were not apparent at earlier stages. The child of ten, for example, is capable of doing many more things than is the child of five or six. Of course, many of the additional things that an older child can do are acquired; but when many different individuals and environments are considered, many new traits are found to appear in such distinct forms and with such unfailing regularity that they seem to be relatively uninfluenced by environmental factors. In order to be of the greatest service in isolating inherited traits, however, this method must be carefully employed. The investigator must show that the traits under consideration are directly associated with the growth and development of the structures. (5)

Studies of Group Likenesses

Another method that has been used to indicate the presence and effects of hereditary factors is that of measuring the abilities and achievements of large groups of persons, such as men of genius, criminals, delinquents, particular families, people of different nationalities, and the like. When groups of this kind are studied, an effort is usually made to show that hereditary factors are associated with the dominant traits of resemblance. Some effort is usually made also to trace the descendants of some particular family to discover to what extent various tendencies exist. If there is a strong tendency for a particular trait to persist in individuals of a given lineage, as intelligence or musical talent, the trait may be considered inherited. There is danger in using this method, however, for the reason that the factors under consideration are not capable of being isolated very well. Musical talent, e.g., might exist in a particular family over a long period of time and still be an acquired trait. The possession of such talent might conceivably be the effects of

training and cultural surroundings that persisted in the family. (6)

Constancy of a Given Trait

Still another useful method of distinguishing inherited from acquired traits is that of noting the manner in which particular capacities and functions persist in the individual in the same amount or in the same pattern. Acquired capacities and functions exhibit a strong tendency to atrophy or grow less with disuse; and if not used over a long period of time, they may disappear altogether. This is not the case with inherited capacities and functions. These seem to be more permanent and to persist longer if not used during a long period of time. At least, there will be little tendency for them to atrophy with age. This difference in the permanency or in the transitoriness of inherited and acquired traits is, therefore, a criterion by which they are distinguished from each other. (3)

In the pages that follow, we shall have occasion to illustrate these different methods. We shall indicate many of the traits that are usually accepted as inherited, and when necessary show the reasons why they are accepted. The task of calling attention to all inherited traits is too great for us to undertake in this text. What we shall need to do is to organize traits of different kinds into classes, and to define the class terms. The student should study the meanings of these terms, as they are employed in psychology; and learn to supply additional examples of those given, by naming particular traits which may come under his own observation. Since we are dealing with human traits, each student has the opportunity of studying himself and others in order to discover concrete examples.

EXERCISES

1. Classify the factors, forces, and influences which comprise man's environment.
2. Give the meaning of each of the following terms: (1) trait, (2) structure, (3) function, (4) capacity. In what sense may any of them be hereditary? Give the synonyms of the term "heredity."
3. What is meant by each of the following: (1) zygote, (2) ovum, (3) sperm, (4) fertilization, (5) gene?
4. In what sense is any trait inherited? Why do inherited traits differ among individuals?

5. How does the psychologist discover what traits are inherited? What assumptions does he have to make in regard to each method?
6. Show how environment and heredity are inseparable; that they constitute different phases of the same totality.
7. Why are some psychologists particularly interested in studying twins?
8. Why are educational psychologists particularly interested in isolating traits which appear in connection with structural growth?
9. Observe your own peculiar or specific characteristics, and make a list of those that you think are inherited.
10. Why must the operations of the genes in heredity be based on hypothetical assertions? Why not on facts?

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CHAPTER IV

BODILY STRUCTURES AND THEIR FUNCTIONS

GENERAL CHARACTERISTICS

Introduction

In the previous chapter, an effort was made to indicate the nature of the environment to which a human being must adjust and to suggest that the possibilities of adjustment depend, in part, upon his inherited equipment. The purpose of this chapter is to present a brief description of the human being's most basic equipment, that of his bodily organs, and to show how different types of organs are involved in performing each type of function. The plan of discussion is to describe at the outset the human organism as a whole, and then to give attention to the structure and functions of different types of organs.

As the student pursues this chapter, he may feel that he is studying physiology, but he is only getting acquainted with the organs of behavior. He should study the materials in this chapter most carefully with the idea in mind that every fact and principle being presented is intended by the authors as a background for understanding much of the material of subsequent chapters. In other words, the student should bear in mind that he cannot understand behavior until he has some knowledge of the organism that behaves.

The General Nature of the Human Organism

How It Is Made

Any living organism should be regarded as "a highly specialized system of material substances consisting mainly of carbon, hydrogen, oxygen, and nitrogen, integrated into a cell or system of cells, the entire complex being capable of maintaining its existence as a unitary system." (Warren.) If we think of individual cells as the elements or smallest parts of the individual, we can get some idea of how the organism is made.

First, the cell, though consisting of many special parts, is the most fundamental or elementary structural unit. Second, similar cells performing a common function are joined to form tissues, of which there are many special varieties. Third, tissues constitute the gross structures of bodily organs, each of which is a group of integrated cells performing a given function. Fourth, the organs of the body are integrated into systems, a system being a group of organs performing a complicated function. Finally, a number of interrelated systems constitute the human organism.

Its Psychological Functions

Only occasionally is the psychologist interested in the functions of individual cells, or even in the physiological functions of tissues, organs, and systems; he is chiefly interested in the functions of the organism as a whole. These functions, it will be recalled, are behavior, adjustment, and learning. For purposes of study, these general functions are regarded as consisting of reactions, and reactions are reduced to responses to stimuli; so that the unit of behavior is a response-to-a-stimulus. This is likewise regarded as the functional unit of the organism. Moreover, when any response to a stimulus is studied in relation to the physiological structures involved in its execution, it will be found to be the function of several types of organs located in widely different parts of the organism. In other words, the execution of a response is not a function of independent cells, tissues, or organs; it is rather a function of the organism as a whole, or of different types of organs which perform certain functions in relation to each other.

It is now our purpose to describe the different types of organs involved in the execution of responses, and to indicate the structure and function of each.

Types of Bodily Organs and Their Functions

Types

If we think in terms of the reaction hypothesis, or in terms of adjustment and behavior, we may classify bodily organs into three types, as follows: (a) receiving organs or receptors, (b) con-

necting organs or connectors, and (c) reacting organs or reactors. The *receptors* are sensitive cells found in sense organs, including such structures as the eyes, ears, skin, nose, and tongue. These are called *sense organs* because through them we sense or become aware of various forces in the environment. The *connectors* comprise numerous cells and parts of the nervous system. A nerve cell is the structural unit of the nervous system and is commonly called a neuron. It consists of a cell body and usually of thread-like projections. The *reactors* are the moving or responding organs of the body. These are commonly thought of as including the muscles, glands, and brain.

Functions

As indicated above, the function of the three types of organs working conjointly is that of responding to stimuli. (a) The receptors receive stimuli from various sources and change or convert them into nerve impulses. (b) The neurons conduct nerve impulses from the receptors to the reactors, and furnish functional connections between them. That is, they receive nerve impulses from the receptors and conduct them to the reactors. (c) The reactors respond to nervous energy received from the neurons, exhibiting such forms of behavior as movements, secretions, and conscious processes.

These separate functions are performed in continuous relation to each other, not as isolated phenomena. The entire process of responding-to-a-stimulus may be summarized as follows: (a) a stimulus acts on a receptor or group of receptors; (b) the receptor initiates a nerve impulse or group of nerve impulses; (c) the nerve impulse is conducted by the neurons to one or more reactors; (d) the reactor moves, secretes, or gives rise to some form of conscious behavior, depending on the type of reactor aroused.

The essential feature of a reaction, it may be seen, is the conversion of a stimulus into nervous energy and the subsequent transmission of this energy to responding organs. In fact, this phenomenon must occur in every reaction. Were it not for the transmission of nervous energy from a receptor to a reactor, and the effects of nervous energy on the reactors, there would be no reactions. Nervous energy, or nerve impulses, in other

words, arouse muscles to action, cause glands to produce secretions, and make it possible for the brain to produce such functions as sensing, feeling, and thinking. How nervous energy occasions these processes will be discussed in a subsequent paragraph.

Since we have indicated the unitary or interdependent functioning of three types of bodily organs, we shall now study the structure and functions of each of the different types.

THE RECEPTORS

Classification

According to Sources of Stimuli

The receptors may be divided, according to the sources of their normal stimuli, into three classes. These are (a) exteroceptors, (b) proprioceptors, and (c) interoceptors. The *exteroceptors* are receptors that receive stimuli, such as light, sound, and heat, which arise at a distance from, or in contact with, the organism. These receptors are divided into (a) contact receptors, including the taste buds and cutaneous or skin receptors, and (b) distance receptors, including the sensitive parts of the eye, ear, and olfactory region. The *proprioceptors* are stimulated by the organism itself, particularly by its movements and positions. This group includes the kinaesthetic receptors in the tendons, muscles, and joints, and the static receptors near the inner ear. The *interoceptors* include numerous receptors found in the body cavity in and about the internal organs. These receptors are stimulated by activities and conditions within the organism. (10)

According to Sensory Functions

Another manner of classifying the receptors is to divide and name them according to their different functions. This form of classification has been followed in making the chart shown below. In it is shown the type of receptor or sense, the common name which is given it, and the name of the receptor, and the kinds of stimuli which normally affect it. The student will notice that there are some types of senses for which there are no common names. (6)

adjusting the lens. The *vitreous humor* is a clear, transparent gel of semi-solid consistency in the eye-ball which serves to hold the ball in shape, and thus to keep the parts in their various relations to each other. The space between the lens and cornea is also filled with *acqueous humor*. The *retina* is the part

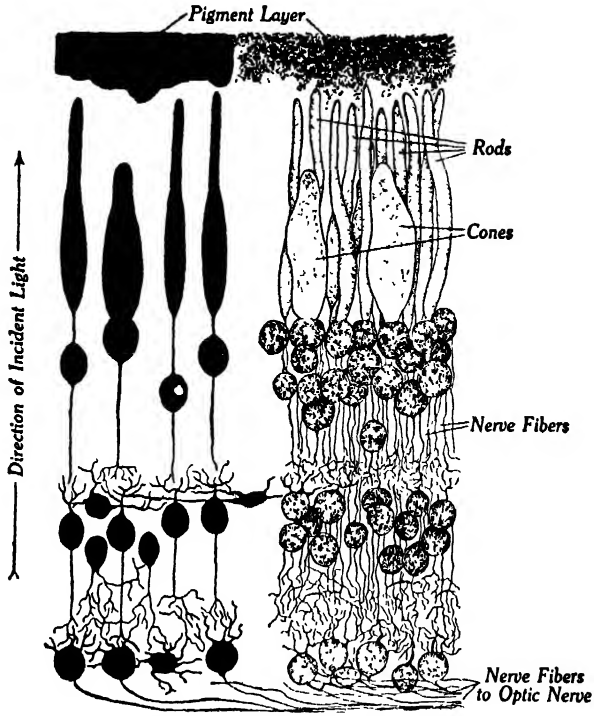

FIG. 2. Rods and cones of the retina, greatly enlarged.

of the eye which is sensitive to light. It is composed largely of nerve cells called rods and cones. An examination of the drawing (Fig. 2) will make clear the nature of these nerve cells. The drawings on the left are merely schematic, while those on the right are actual reproductions of human rods and cones. Notice the differences in structure between the rods and cones, and also the variety of nerve connections for each. The rods are affected by all wave-lengths of light, but the sensations resulting from their excitation are all grays of different brightness. The cones are affected by all wave-lengths of light, and they produce sensations of white, gray, black,

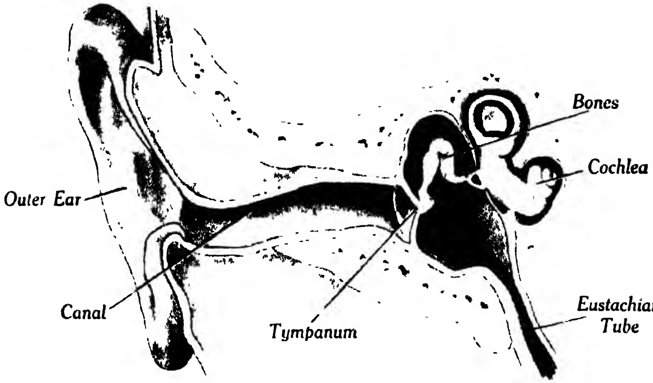

FIG. 3. Cross section of the ear, showing outer ear, canal, tympanum, three bones, cochlea, and the eustachian tube

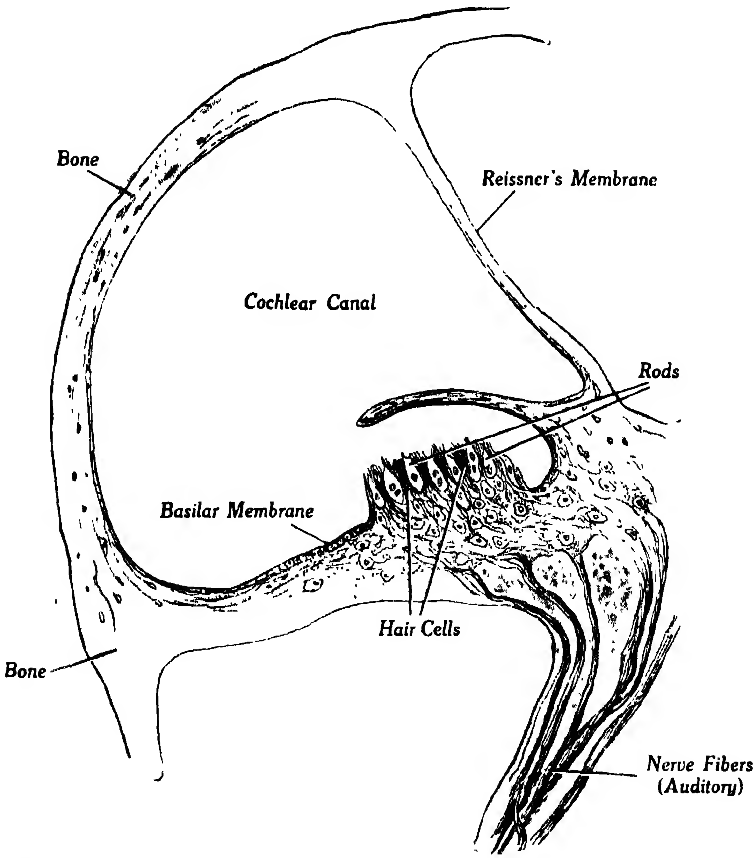

FIG. 4. Diagram of a section through the cochlea showing the organ of Corti.

and all the colors. Light rays enter the eye through the cornea, a transparent layer of tissue, pass through the pupil or hole in the iris, and those from a point fixated are brought to a focus on the fovea centralis, which is a small part of the retina directly back of the lens, and in which the cones are concentrated in great numbers. The *fovea centralis* is located opposite the pupil, and is the most sensitive part of the retina. The rays which strike the retina are usually reflected from some object in such a manner that visual representation of the object is focused on the fovea. The effects of light rays on the rods and cones are not definitely known. It is certain, however, that a stimulation occurs which sets up nerve impulses that are conducted to the brain or other parts of the nervous system over nerve fibers which are attached to the rods and cones. The rods and cones constitute the receptors of the eye, while the other parts compose the accessory apparatus necessary for the proper accommodation and protection of the eyes. It may be observed that the rods constitute one group of receptors, and the cones another group. It is possible for a person to have defective cones and yet be able to see. Such a person would be able to see objects in light and dark shades, but he would not be able to distinguish between colors. In such a case the person is color blind. (8)

Auditory Receptors

The sense organ for audition or hearing is the ear, a cross section of which is shown in Fig. 3. This drawing shows the outer ear, canal, tympanum, three bones, and cochlea. It also shows the eustachian tube, which will be discussed later. These several parts are useful in hearing, but the receptors are certain hair cells located in the *cochlea* of the inner ear. An enlarged drawing of these hair cells is shown in Fig. 4. These cells are sensitive to sound waves of a certain range of frequencies, normally between 16 and 20,000 vibrations per second. Air waves set up by a vibrating object are transmitted to the sensitive cells by means of the *tympanum*, which is a thin drum-like (ear drum) membrane placed across the passage from the outer to the middle ear, and three bones known as the *hammer*, *anvil*, and *stirrup*. The hammer is attached to the tympanum or ear drum which is set into motion by the waves from with-

out. The vibrating hammer strikes against the anvil, and the latter articulates with the stirrup. This stirrup vibrates over a membrane covering an opening or oval window to the cochlea in which are the hair cells. Some of these hair cells are short and others are long, and they are arranged in a manner similar to the strings of a piano. It is thought that the short fibers are stimulated by waves producing sounds of high pitch, and the long fibers by waves producing sounds of low pitch, and that the volume of sound depends upon the number of hair cells which are stimulated simultaneously. The effect of stimulating any of the hair cells is that of initiating a nerve impulse or group of nerve impulses. These are conducted to the brain and other reactors over the auditory nerve fibers attached to the sensitive cells. (8)

Olfactory Receptors

Olfactory receptors are sensitive to gaseous particles floating in the air. These receptors are located in the upper nasal cavity and cover an area of tissue about the size of a dime. They are in the form of sensitive cells lying between supporting tissues, and extend somewhat above the surface. An idea of the parts of the olfactory region, and of the general arrangement of these parts, may be had by studying the reproduction in Fig. 5. The olfactory area is shown somewhat enlarged, and the olfactory receptors (nerve cells) are easily seen. Gaseous particles are sniffed into the nostrils by the act of breathing, and these make contact with the ends of the nerve cells thereby stimulating them. The fibers from these cells are connected to nerve fibers which terminate in the olfactory lobes of the brain. It should be clear to the student that only those substances which evaporate (become gases) have odors, and that these odors are conveyed to the olfactory receptors when air is inhaled through the nostrils. (8)

Gustatory Receptors

Gustatory receptors are called taste buds. These are sensitive to substances in solution, generally found in foods. A drawing of the tongue is shown in Fig. 6. On it are shown four types of taste buds: those sensitive to sweet substances, located on the tip and sides of the tongue; those sensitive to sour and bitter

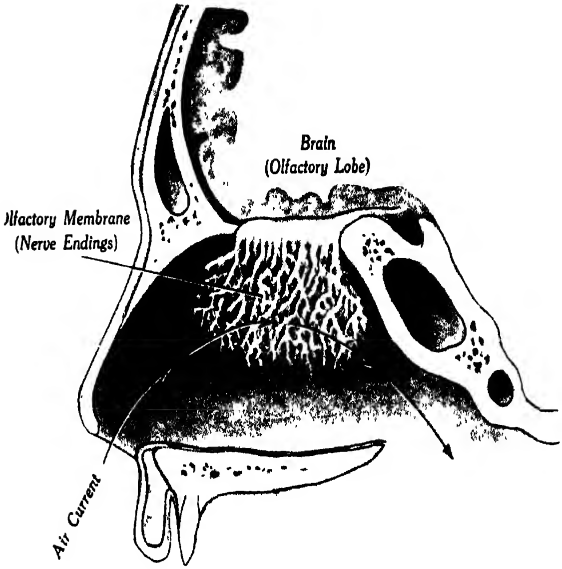

FIG 5 Cross section of the nasal cavity showing the olfactory area somewhat enlarged.

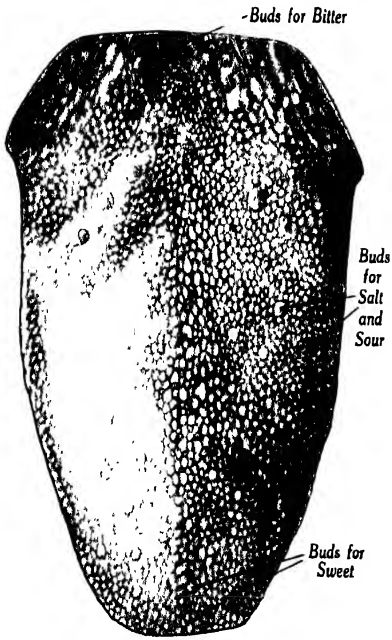

FIG. 6. An enlarged drawing of the tongue showing the general locations of taste buds.

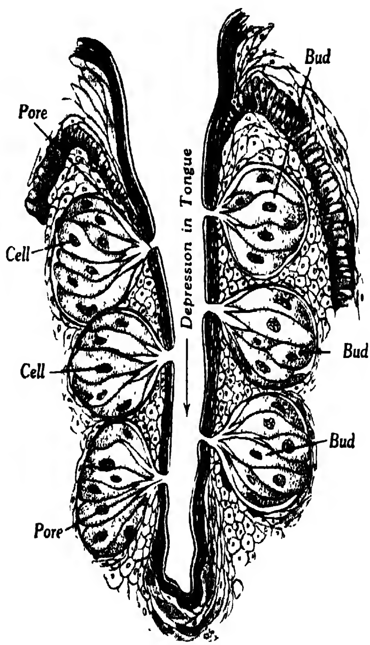

FIG. 7. A highly magnified depression in the tongue showing six taste buds.

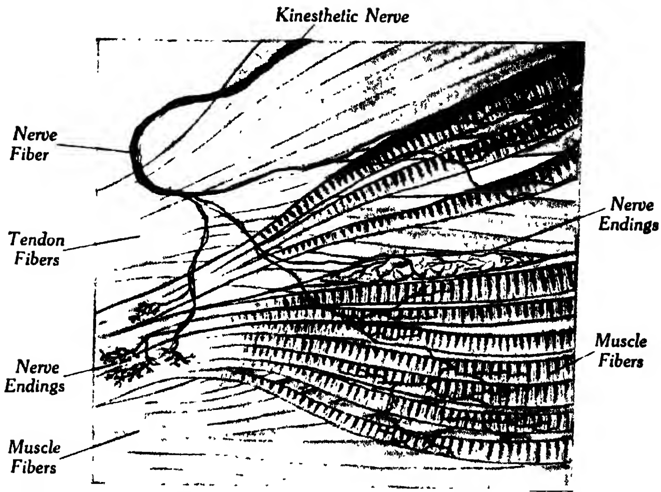

FIG. 8. A highly magnified section of muscle and tendon fibers showing kinesthetic nerve endings.

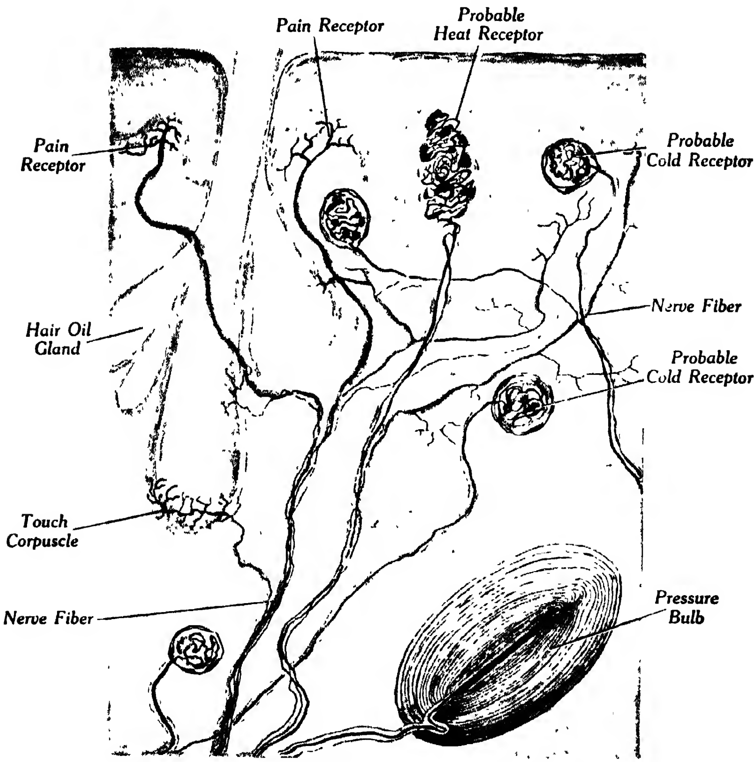

FIG. 9. Tactual receptors A greatly enlarged drawing of pain receptors, touch corpuscles, pressure bulbs, receptors for heat, and receptors for cold.

substances, located on the sides and back of the tongue; and those sensitive to salt, distributed over the entire surface of the tongue. When an appropriate soluble substance comes in contact with a taste bud, a nerve impulse is initiated and makes its way to the brain or other reactors. An enlarged drawing of six taste buds is shown in Fig. 7. A study of the structure of these receptors will help the pupil to understand how liquids serve as stimuli for them. Gustatory and olfactory receptors are often referred to as the chemical senses.

Kinaesthetic Receptors

These receptors are found in the muscles, tendons, and joints, and are stimulated by the movements of the muscles and limbs. The receptors are in the form of fine nerve branches which twine around muscle fibers, tendon tissues, and other fibers which connect with the cartilages of the joints. A careful study of the section shown in Fig. 8 will give the reader a clear idea of muscle structure as well as of the kinaesthetic nerve endings which are the receptors. Note especially the very fine nerve endings, at least one to each muscle fiber. These endings are stimulated by the contraction or relaxation of the muscles, by the pull and strain of tendons, and by the gliding of the cartilages of the joints over each other. It is through kinaesthetic receptors that the movements of muscles are sensed.

Tactual Receptors

These receptors are found in the skin. They are stimulated by objects which come into contact with the organism. Of these there seem to be five groups which differ both in structure and function. They are (a) pain receptors, (b) touch corpuscles, (c) pressure bulbs, (d) "warm spots," and (e) "cold spots." Figure 9 shows an example of each of these five types. *Pain receptors*, for which no name has been proposed, are in the nature of free nerve endings found in the skin, and in almost all of the body tissues. They are stimulated by sharp objects which tend to tear or injure the tissues. The *touch corpuscles* are found near the surface of the skin, twined around the roots of hairs, and possibly in the surface of internal organs. They are stimulated mechanically by objects coming in contact with the skin or hairs. *Pressure bulbs* are found in deep lying parts of the skin,

and possibly in muscle tissue. They are stimulated by pressure of objects against the skin. "*Warm spots*" and "*cold spots*" designate receptors which are sensitive to thermal (heat) stimuli. If a blunt metal point be warmed and moved over the surface of the skin, the "cold spots" will not be found in the same places as are the warm spots. This simple test indicates different receptors for each type of stimuli. Thus the cutaneous receptors include as many as five different kinds of structures sensitive to as many different environmental forces. (4)

Static Receptors

The static receptors include the utricle and saccule, and the semi-circular canals. These organs are located near the cochlea of the inner ear and lie in a vestibule or bony cavity of the skull. The diagrams in Fig. 10 show an enlarged view of these parts. On the inner walls of the semi-circular canals, and within the utricle and saccule, are tufts of hair-like cells which project outward into a fluid which fills the canals. At the base of these cells are nerve fibers with which they connect, and which go to the cerebellum. The hair cells constitute the receptors. These are stimulated by movements of the liquid into which they are projected, this liquid being set in motion by movements or changes in the position of the head. The canals lie in different planes, there being one in the horizontal and two in the vertical, and all three being at right angles with each other. Head movements in any direction will, therefore, result in a change in the position of the liquid, and thus a stimulation of the hair cells. It is obvious that these receptors are involved in maintaining equilibrium, position, and movement in a given direction.

THE NERVOUS SYSTEM

Main Divisions

The nervous system is divided into two main divisions usually designated as the *cerebro-spinal* and the *autonomic*. The *cerebro-spinal* system is made up of the (a) central nervous system and (b) the peripheral nerves. The central nervous system includes the (a) brain and (b) spinal cord. The peripheral nerves are made up of nerve fibers distributed throughout the trunk and limbs. The *autonomic nervous system* is a mass of nerve tissue

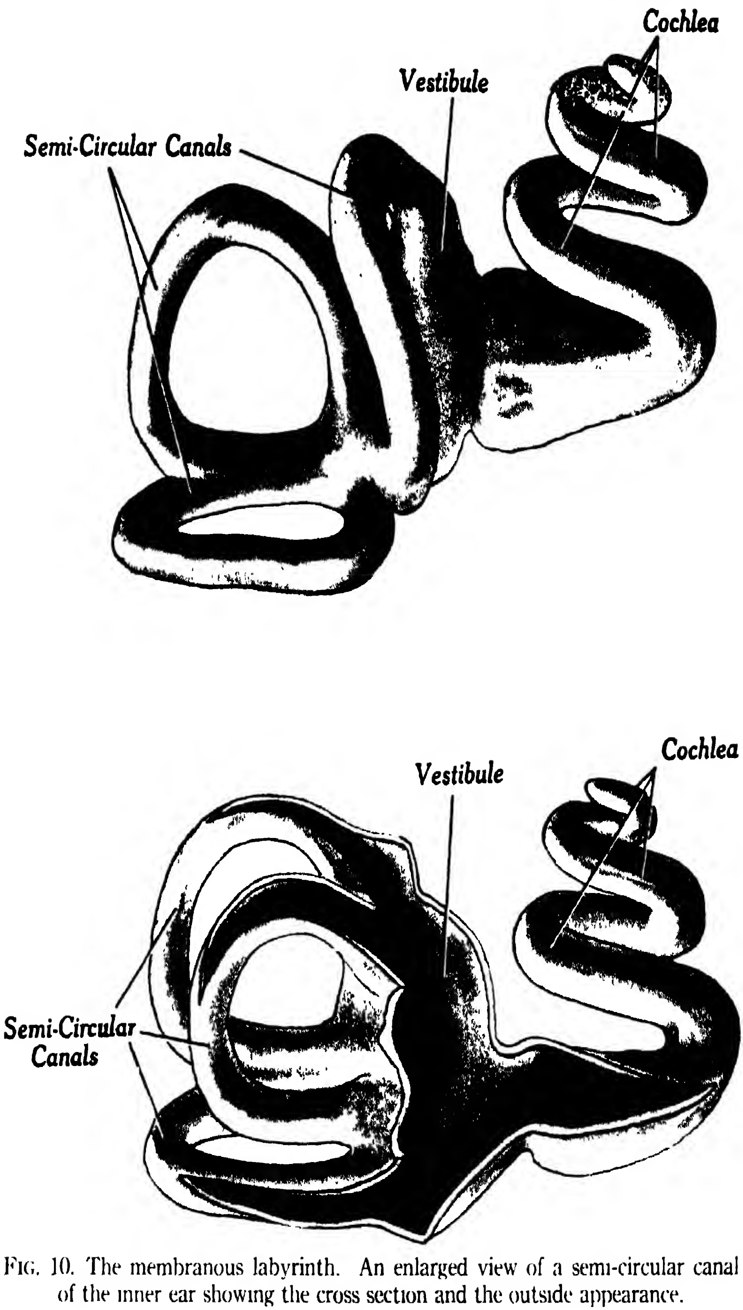

FIG. 10. The membranous labyrinth. An enlarged view of a semi-circular canal of the inner ear showing the cross section and the outside appearance.

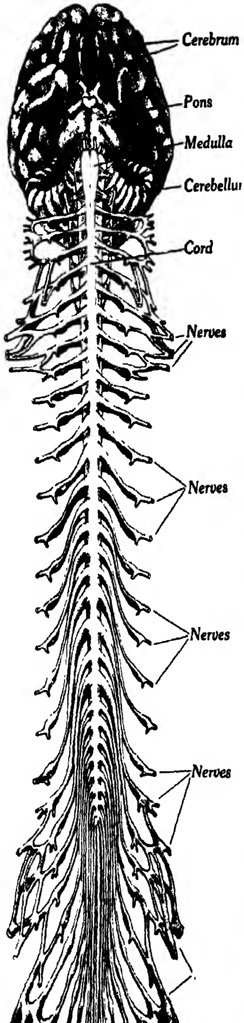

FIG. 11. The cerebro-spinal nervous system. A greatly reduced drawing showing the brain and the spinal cord together with the 31 pairs of nerves which branch from the cord

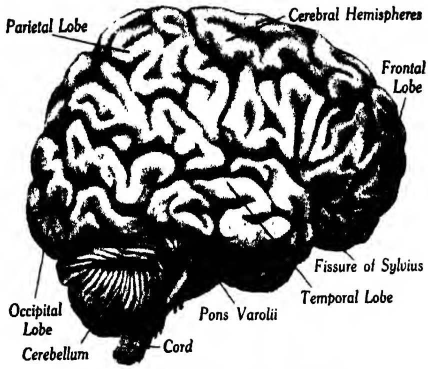

FIG. 12. The brain shown from the right side.

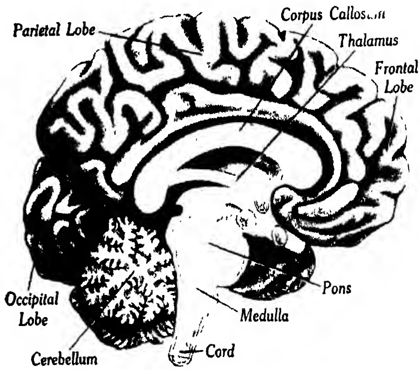

FIG. 13. Convoluted inner surface of the left side of the brain

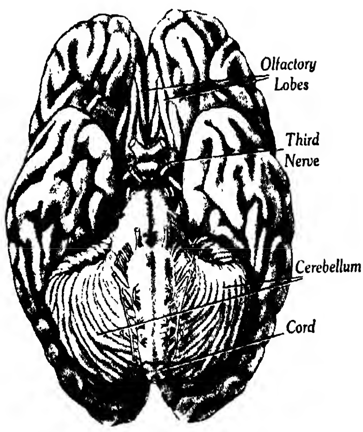

FIG. 14. The base of the brain. The cerebral hemispheres are seen to overlap the other parts.

and nerves found in the body cavity. This, like the peripheral nerves, is a branch of the general nervous system. Each of these divisions will be described. (1)

The Cerebro-Spinal Nervous System

THE CENTRAL NERVOUS SYSTEM. The *brain* is a mass of nerve tissue encased in the skull, and the *cord* is an elongated mass of nerve tissue encased in the vertebral column (backbone). The diagram in Fig. 11 represents the brain and cord. It should be pointed out that this representation is schematic and that the sizes and proportions of the parts are not exact. The largest part of the brain is called the *cerebrum*, which is divided into the left and right hemispheres by means of a deep fissure running from front to back. The two hemispheres or cerebra are held together by a band of cross fibers known as the *corpus callosum*. The surface of the cerebrum is a grayish colored tissue about one-fourth of an inch thick called the *cerebral cortex*. The amount of "gray matter" is increased by folds or convolutions which give the surface a rough appearance. For convenience, in referring to the various parts of the cerebrum, it has been divided into lobes; the *frontal lobe* which occupies the front, the *occipital lobe* the back, the *parietal lobe* the upper central part immediately behind the fissure of Rolando, and the *temporal* the lower sides and front near the temples.

Another large section of the brain is the *cerebellum*, a large mass of tissue lying at the base and back of the cerebrum. Below and in front of the cerebellum is the *medulla oblongata*, an enlarged portion of the spinal cord. In front of the medulla is the *pons*, a band of nerve fibers which joins the parts of the cerebellum. Above the medulla, and enfolded by the hemispheres, is the *thalamus* which, together with the pons and medulla, make up the *brain stem*. Figures 12, 13, and 14 show the parts of the brain which have been described above. The pupil should study these drawings until he gets a clear idea of the parts they represent.

The Peripheral Nervous System

The *peripheral* or *spinal nerves* are composed of *sensory* fibers coming into the spinal cord from the receptors, and of *motor* fibers going from the spinal cord to the muscles of the limbs.

A *nerve* is a bundle of fibers surrounded by a sheath, and can be seen with the natural eye. There are thirty-one pairs of these nerves, named as follows: cervical (eight pairs); thoracic (twelve pairs); lumbar (five pairs); sacral (five pairs); and coccygeal (one pair). Each nerve is attached to the cord by two roots, one each at the front and back. The front root is composed chiefly of sensory fibers, and the back root of motor fibers. A careful study of Fig. 11 should help the reader to understand the above description. (3)

The Autonomic Nervous System

DIVISIONS. A study of Figs. 15 and 16 will show that the autonomic nervous system has two principal divisions, known as the *parasympathetic* and the *sympathetic*. The parasympathetic division consists of two sub-divisions, the cranial and sacral, which are usually described as two separate systems, a practice which makes the autonomic nervous system appear to be composed of three divisions. The *cranial* division is composed of a chain of nerve ganglia (collections of nerve cells) attached to the medulla. These ganglia are located among the internal organs of the upper part of the body cavity. Extending out from these ganglia are nerve fibers which supply the salivary glands, bronchi (lungs), heart, liver, pancreas, kidneys, stomach, upper intestines, and other internal organs of this region. The sacral system consists of ganglia supplying organs of the pelvic region; the colon, rectum, genitals, bladder, reproductive organs, and others. This mass of nerve tissue is attached to the lower end of the spinal cord. The *sympathetic* division consists of two chains of ganglia extending the full length of the vertebral column, but lying in front of this bony cavity. There are also included several masses of nerve tissue in the region of the heart, stomach, and pelvic region. These masses, together with those that belong to the cranial and sacral divisions, are called *plexuses*, which constitute nerve centers from which numerous fibers extend to the various internal organs. Though the cranial and sacral division each supplies a different group of organs, the sympathetic division supplies practically every organ of the body cavity.

CONNECTION WITH CENTRAL NERVOUS SYSTEM. All three of these divisions are connected with the central nervous system

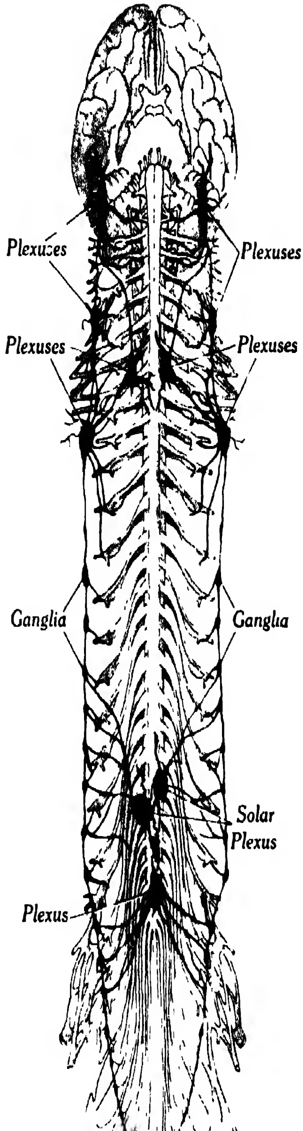

FIG. 15 Diagram of the autonomic nervous system, showing the locations and connections of several ganglia to the spinal cord.

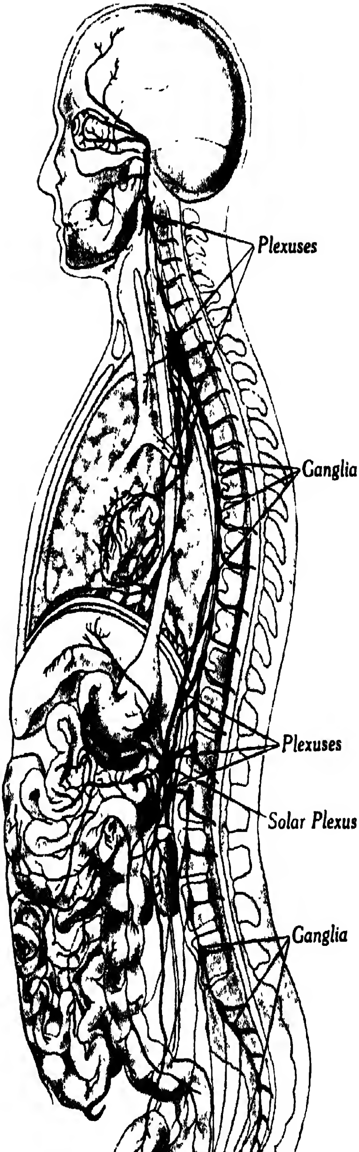

FIG. 16. Diagram of the autonomic nervous system showing the neural connections to the various internal organs.

by means of *preganglionic* fibers which originate in the medulla and spinal cord and end in the autonomic ganglia. These are called "preganglionic" fibers to distinguish them from ganglionic fibers which extend from a ganglion to a particular organ. The preganglionic fibers extending out from the medulla connect that important center of the central nervous system with nerve ganglia which form the cranial system. Those extending out from the lower end of the cord connect with the sacral ganglia. The preganglionic fibers that extend out from the various joints of the vertebrae, and branch off from the thirty-one spinal nerves, are attached to the sympathetic ganglia.

Sensory fibers make connections mainly in the medulla with autonomic fibers, and originate with the receptors in the internal tissues. Some of these belong to the autonomic system, but some also belong to the cerebro-spinal system. It is these latter that enable the organism to become aware of conditions and events among the internal organs.

Microscopic Features of the Nervous System

Nerve Cells

The gross structures described above are easily located on most charts and diagrams of the nervous system. Attention will now be called to those features of the nervous system that are revealed by the microscope. These include the (a) neurons or nerve cells, and (b) certain other tissues known as myelin sheaths, and neuroglia. A discussion of these will help to throw light on the nature and functions of the gross structures indicated above.

Neurons and Their Functions

The term "neuron," as we have seen, is applied to nerve cells which conduct and transmit nervous energy from the receptors to the reactors. Each neuron is composed of a *cell body*, which corresponds to the nucleus of other types of cells, and various branching processes called axons, end brushes, dendrites, and end plates. Regardless of the fact that neurons are composed of separate parts, each neuron should be thought of as a unitary structure.

By studying neurons under the microscope, physiologists

have been able to identify four different types and the kinds of branching processes belonging to each, and to determine the function of each type. The four types that have been identified are (a) sensory, (b) motor, (c) connecting, and (d) association or

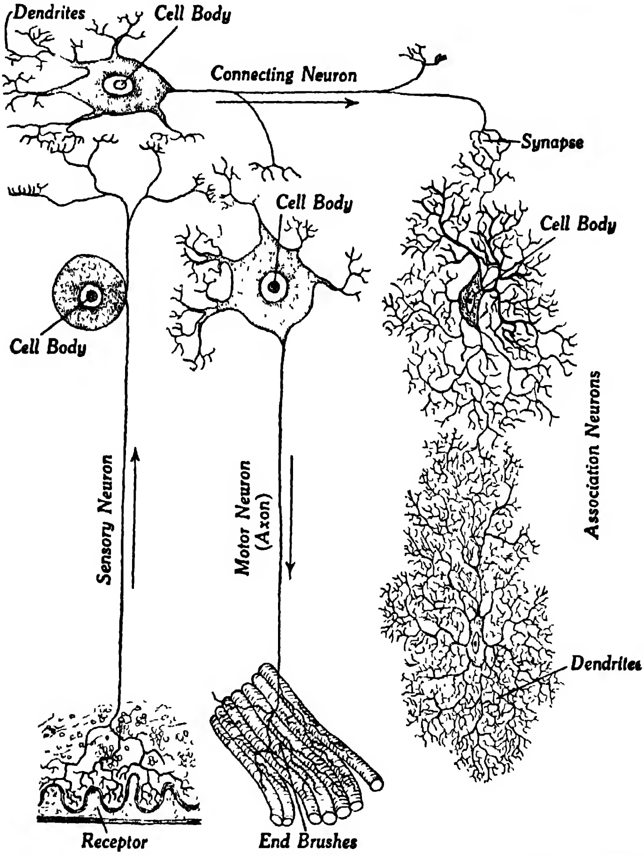

FIG. 17. Diagram showing various types of neurons very highly magnified.

cortical. Each of these is illustrated by the separate sketches in Fig. 17.

Sensory neurons, it may be pointed out, originate in the sense organs and end in the central nervous system. Their beginnings are the *end organs*, a term frequently applied to the receptors. Leading from the receptors toward the central nervous system is a long fiber called the *sensory axon*, which ends at the cell body located in the spinal ganglia just outside of the spinal

cord. Numerous arborizations called *end brushes*, branch out from the cell body, and extend into the central part of the spinal cord or brain. Some of these cells end in the spinal cord, others in the medulla and cerebellum, and still others end in various centers of the cortex.

The function of sensory neurons is that of receiving nervous energy from the receptors and conducting it to parts of the central nervous system. Here the energy is transmitted by the sensory neurons to motor or to connecting neurons, across the synapses.

Motor neurons originate in the central nervous system and extend to muscles and glands. Each of these begins with the *dendrites*, which are branching processes that converge to the cell body. The cell bodies of the motor neurons are all found within the central nervous system, some being in the spinal cord, others in the medulla or cerebellum, and others in the cortex. The *motor axon* extends out to the muscle or gland from the cell body of a motor neuron. It is the conducting part of the cell. Upon reaching a reacting organ, the axon branches out to form the *end plate*, which consists of a number of nerve fibers attached to numerous tissues of the muscle or gland.

The function of motor neurons is to receive nervous energy from the sensory or connecting neurons and to transmit it to the different reactors. Impulses are received by the dendrites at the synapses and conducted from them to the reactors by the *motor axons*. Upon reaching the end plates, the nervous energy is discharged into the cells of the reactor.

Connecting neurons begin and end in the central nervous system. They begin with dendrites as do the motor neurons. Extending out from the cell body of each cell is the *connecting axon*, and at the end of this axon is a branching process constituting the *end brush*. Thus, at the receiving ends, connecting neurons resemble motor neurons; and at the discharging ends, they resemble sensory neurons. There are millions of these neurons in the central nervous system. Some, known as *afferent* connecting neurons originate in the lower levels of the central nervous system and extend to higher levels, as those from the spinal cord to the medulla or cerebellum or to the cortex. Others, known as *efferent* connecting neurons originate in the higher levels, as the cortex or thalamus, and extend to and end in the lower levels.

The function of connecting neurons is that of conducting nervous energy from one level of the nervous system to another. In doing this, the afferent neurons receive nervous energy from sensory neurons and conduct it to the central nervous system. Here the nervous energy is received by the efferent connecting neurons and conducted to a lower level, and from there to the reactor by way of the motor neurons. The transfer of the nervous energy from one type of neuron to another is made, of course, at the synapses, which appear as junctures between the end brushes and dendrites of the several types of neurons.

Association or *cortical neurons* are found in the cerebral cortex. These are very similar to connecting neurons, except that they are more complicated and have very short axons. That is, they consist of numerous dendrites converging to the cell bodies and of numerous arborizations forming complicated end brushes branching out from short axons. These cells constitute the gray matter of the cortex. They are probably more numerous than any of the other types of nerve cells.

The association neurons appear to perform a double function. First, they conduct nervous energy from one part of the cortex to another, forming a network of connections by which every part of the cortex is functionally connected with every other part. Second, these neurons serve as reacting organs for conscious activity. It is believed that such functions as sensing, perceiving, thinking, and imagining are the effects produced by the discharge of nervous energy among the cortical neurons.

Other Tissues

The nervous system is not composed entirely of neurons; it is made up also of other types of cells. Each sensory and motor axon is covered with *myelin sheath*, which consists of a white, fatty substance that envelops the fibers. The sheath extends from the beginning of sensory axons to the cell bodies, and from the cell bodies of motor neurons to the end plates. It likewise envelops the axons of the connecting neurons. The function of myelin sheaths is that of insulating each axon from others adjacent to it in the numerous nerves, thus preventing "short circuits" of the nerve impulses.

Another type of nervous tissue is known as *neuroglia*. This is a white substance within the central nervous system and it sup-

ports and holds the connecting neurons together. The tissue is found in large quantities in the cortex and in smaller amounts in the cerebellum, medulla, and spinal cord. This tissue, together with myelin sheaths, constitutes the major portion of the "white matter" of the nervous system.

The nervous system also contains many blood vessels. These supply the nerve cells with food and remove accumulating poisons and other waste products.

The Nature of Nervous Conduction

The conduction and transmission of nervous energy from receptors to reactors depends, to a large extent, upon the anatomical as well as the physiological characteristics of the nerve cells. In other words, the nerve cell is not merely a conductor of nerve impulses received from the receptors. The nerve impulse itself is as much a product of the nerve cell as of receptor stimulation. This is why it has been impossible to generate nervous energy by any artificial means and why nerve impulses continue to be discharged into reactors some time after active stimulation has ceased. A brief statement of the *membrane hypothesis of nerve conduction* and a brief description of various reaction levels will help to make clearer the nature of nervous conduction and transmission.

The Membrane Hypothesis

According to this hypothesis, nerve conduction is a phenomenon associated with the anatomical characteristics of the nerve cell. Each neuron is known to be a semi-permeable, polarized substance. It is semi-permeable in that it offers a degree of resistance to the passage of electrical and chemical elements; it is polarized in that it is charged with positive ions on its outside and with negative ions on its inside surface. When a stimulus arouses a receptor to which such a membrane is attached, the electro-chemical energy emitted by the receptor disturbs the balance of positive and negative ions maintained by the metabolism in the nerve fiber. The effect of the disturbance is that of depolarizing successive portions of the membrane so that it is made permeable to the passage of the electrical and chemical elements. An instant after the depolarization of one point or segment of the axon, that part is in a re-

fractory phase; another instant later, it is in a condition of hyper-excitability; then in another instant, it returns to a normal condition. Thus the nerve current has been characterized as a "wave of depolarization" passing along successive portions of the axon from the point at which the disturbance was initiated to its end. The nerve current, or impulse, therefore, consists of a series of minute pulsations produced by electrical and chemical processes, which follow one another in quick, rythmical succession along a nerve cell. Upon reaching a synapse, the current overcomes another type of resistance and crosses from the sensory end brush to the dendrites of a connecting or motor neuron.

Reaction Levels

The term "reaction levels" has been applied to the nerve centers in the central nervous system in which synapses are made for reactions of varying degrees of complexity. The major centers to which the term refers are: (a) the spinal cord, (b) the medulla, (c) the cerebellum, (d) the thalamus, and (e) the cerebral cortex. Reactions which involve synapses in the spinal cord and medulla are usually very simple, prompt, and certain; and they are known as *reflexes,* or *first level reactions.* These include such simple activities as the knee jerk, grasping, jerking a finger stuck with a pin, and many others. These are called "first level reactions" because they involve only the lower levels of the nervous system. In the execution of such reactions, there is needed only a sense organ, or receptor, a sensory neuron, a synapse in the spinal cord, a motor neuron, and a reactor. The stimulus first arouses the receptor which initiates a nerve impulse; the impulse is taken to the spinal cord where it crosses a synapse to the motor neuron; it is then conducted by this neuron to the muscle or gland. When it reaches the reactor, the impulse spreads over the end plate to the various tissues and touches them off, producing a response.

Second level reactions are comparatively complex motor reactions which involve connections in the medulla or cerebellum. These include such reactions as crying, maintaining balance, walking, jumping when excited, and numerous other inherited reactions, or reactions which do not have to be learned. They likewise include the activities of the internal organs, such as

those involved in digestion, circulation, and respiration. These, it may be observed, are natural reactions with which the individual is equipped at birth.

Third-level reactions include all mental events and processes and acquired muscular and glandular activities. Such forms of behavior are known as third-level reactions because the nerve connections involved in performing them are made in the cerebral cortex. The motor neurons for third-level reactions have their dendrites and cell bodies in an area of the cortex just in front of the fissure of Sylvius. Nerve impulses reach the cortex directly from the sense organs, as will be shown later, and from the spinal cord, medulla, cerebellum, and thalamus. Any activity involving the cortex usually has some degree of conscious activity in connection with it.

The main point in describing these levels of reactions is to illustrate the fact that a nerve impulse originating in a sense organ has the possibility of arousing any or all of the reactors, and that the response aroused depends, in part at least, upon the parts of the nervous system brought into action. In other words, the simplest reactions involve connections in the spinal cord; relatively complex, unlearned reactions involve connections in the cerebellum and medulla; and the most complex reactions involve connections in the cerebral cortex.

In a subsequent section, attention will be called to the special functions of each of these larger nerve centers. In subsequent chapters on learning, an effort will be made to illustrate the functioning of various centers in different types of learning. At the present time, the student should master the essential facts regarding the nervous system.

THE REACTORS

Classification

In the previous discussion frequent references have been made to the *reactors* or organs of response. We come now to a brief survey of this part of the organism's reacting equipment, and to a study of the structures and functions of the different groups of reactors. These organs are divided into three groups, each of which is further divided into two sub-groups: (a) muscles, striped and smooth; (b) glands, duct and ductless; and

(c) brain, sensory and motor centers of the cerebral cortex. The chief function of the muscles is that of responding to stimuli when aroused by nervous energy from the central nervous system. The glands produce secretions and *hormones*, some of which have important effects on the behavior of muscles and nerves. The cerebral cortex appears to produce mental activity or behavior of the subjective type. The nervous energy supplied to these various reactors is initiated by the receptors and conducted by the neurons. How these organs are made, and how they perform their functions will help to make clear our study of behavior.

The Muscles

Striped Muscles

The *striped muscles* are made up of long thread-like cells bound together by connecting tissue. For details, see Fig. 18. These muscles are attached to bones by means of tendons, and are usually arranged as opposite members of a pair placed across a movable joint. One of the muscles in a pair, the *flexor*, serves to bend the joint; the other, the *extensor*, serves to straighten it. In the arm, for example, the bending is done by the biceps, the flexor, and the straightening is done by the triceps, the extensor. A single stimulus serves the double purpose of causing one of a pair of muscles to relax, and the other to contract at the same time. This phenomenon is known as *reciprocal innervation*. To each muscle fiber is attached one or more nerve fibers by means of end plates of the motor neurons. Thus, every muscle fiber receives a part of the nervous energy projected outward from the spinal cord. The chief function of the striped muscles is to maintain posture and to produce movements. (4)

Speech Muscles

The speech muscles comprise a special type of reactor which belongs almost entirely to man. A study of the details of Fig. 19 will help the reader to get a clear idea of this type of musculature. The speech muscles are located in the *tongue* and *larynx*. The tongue is a mass of muscle tissue capable of moving in any direction and of modifying its shape and surface. It is held in place by muscles attached to the skull, hyoid bone, and

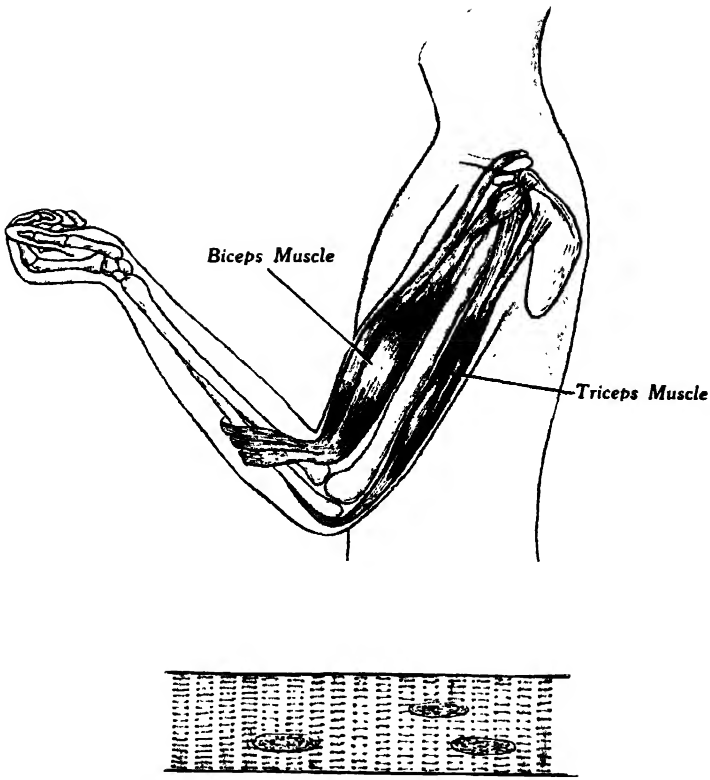

FIG. 18. The main striped muscles of the upper arm The lower drawing shows a single fiber highly magnified.

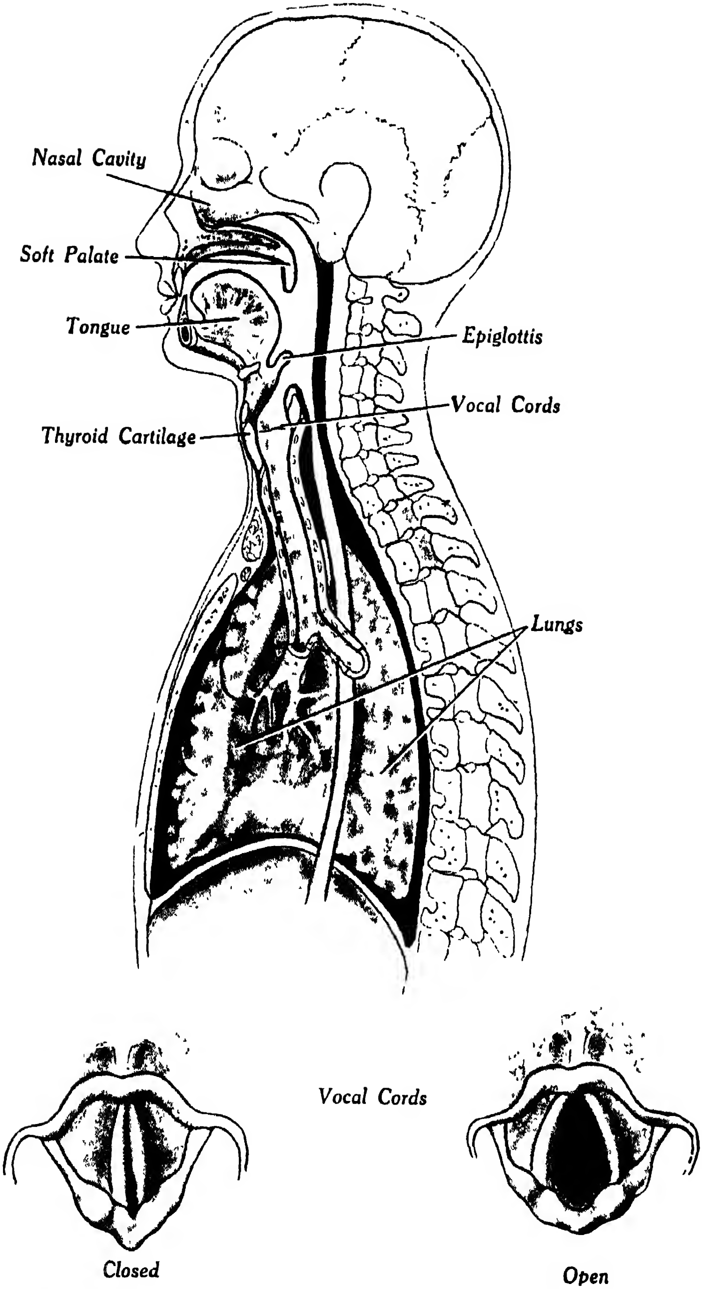

FIG. 19. Diagram of the chief muscular structures involved in vocalization
The lower diagrams show two views of the vocal cords.

lower jaw. These muscles draw the tongue upward, forward, backward, downward, from side to side, etc. Speech, as far as the tongue is concerned, is produced by frictions or explosions of air caused by bringing some part of the tongue near, or in contact with, the teeth, gums, or the hard and soft palate of the roof of the mouth. The larynx contains the *vocal cords* arranged on each side of the *glottis* whose movements help to control the tension of the cords. Sound is produced by blasts of air from the lungs. These blasts pass through the vocal cords and set them in vibration. The entire speech mechanism is too complex to describe here. It is mentioned in order to make the student aware of this important part of man's muscular equipment. The speech mechanism is supplied with nerve impulses by neurons which originate in the middle portion of the frontal lobe of the cerebrum. The function of the speech muscles is vocalization. (8)

Smooth Muscles

These are found in the arteries and veins, lungs, stomach and intestines, the iris of the eye (for opening and closing the pupil), in the ciliary muscle of the eye (which controls the lens), in the muscles of the skin, and in the various organs of the body cavity. Smooth muscles are made of spindle-like cells held together by connective tissue. Smooth muscles react more slowly than striped muscles, and maintain their state of *tonus*, or partial contraction, much longer. As previously stated, the smooth muscles are supplied by nerve fibers belonging to the autonomic nervous system. The activities of these muscles are caused largely by internal stimulation. In special instances, however, the smooth muscles may be affected by external stimulation. When this occurs, the nerve impulses are transferred from the cerebro-spinal system to the autonomic system, and then to the internal organs. The smooth muscles also respond to the effects of glandular secretions. The general or primary function of the smooth muscles is the control of the vital processes, breathing, and circulation. Psychologists have usually refrained from discussing these muscles and their functions, leaving this task to the physiologists. The importance of these muscles in behavior, however, should not be overlooked, for the activities of the internal organs occasioned by the

smooth muscles have a profound effect on the conscious life of the individual. This is particularly true in such experiences as feelings and emotions. Attention will be given to these functions later. (1)

The Duct Glands

Duct glands are glands of external secretion; that is, they pour out their secretions through ducts into some body cavity or opening, or on to the body surface. Examples of duct glands are the tear, sweat, salivary, gastric, and kidneys. The location of some of these is illustrated in Fig. 20. The duct glands are essential to digestion and the elimination of waste products. They are also important organs of response in modifying behavior, especially if they function abnormally. Ordinarily the duct glands are stimulated by external events; for example, the activities of the tear glands in the presence of the oil from an onion, or the activity of the salivary glands when one smells a steak cooking, or even watches another person eat a lemon. These glands are innervated largely by the autonomic nervous system. An enlarged drawing of a hair gland is shown in Fig. 21.

The Ductless Glands

The glands which belong to this group are called *endocrines*, or glands of internal secretion. They have no ducts, but they secrete substances which are taken up by the blood flowing through their porous tissues. When the secretion gets into the blood stream, it is carried quickly to all of the tissues of the body. The secretions of the endocrines are powerful drug-like substances which affect each other, and which excite and inhibit numerous processes and activities. The names of the glands which belong to this group are as follows: pituitary, pineal, thymus, thyroids, parathyroids, adrenals, and gonads. The locations of these glands are shown in Fig. 22. The secretions of these glands act as internal stimuli which profoundly affect human conduct. The glands themselves are stimulated by both internal and external stimuli. They are supplied by nerves from the autonomic nervous system. The nerves, blood vessels, and cell structure of a ductless gland, highly magnified, are shown in Fig. 23.

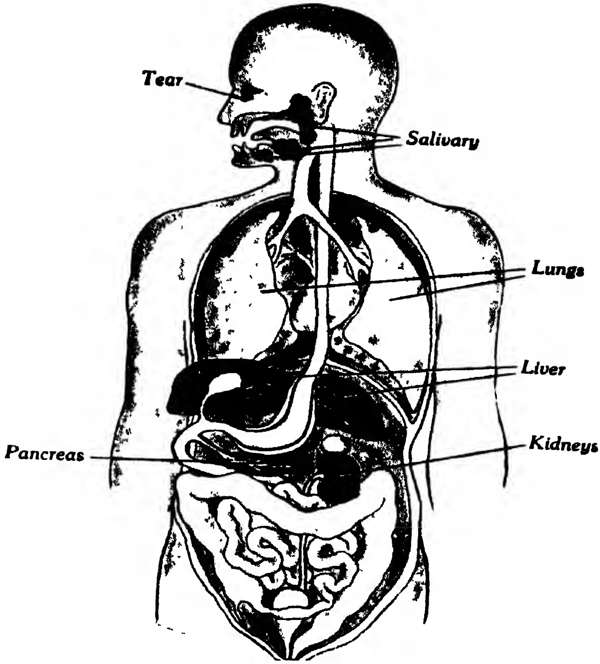

FIG. 20. The general location of the principal duct glands.

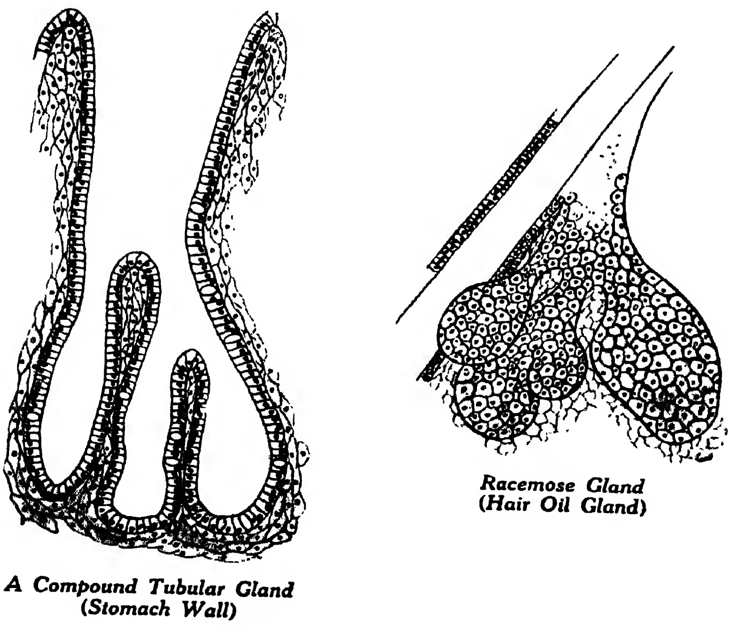

FIG. 21. Duct glands.

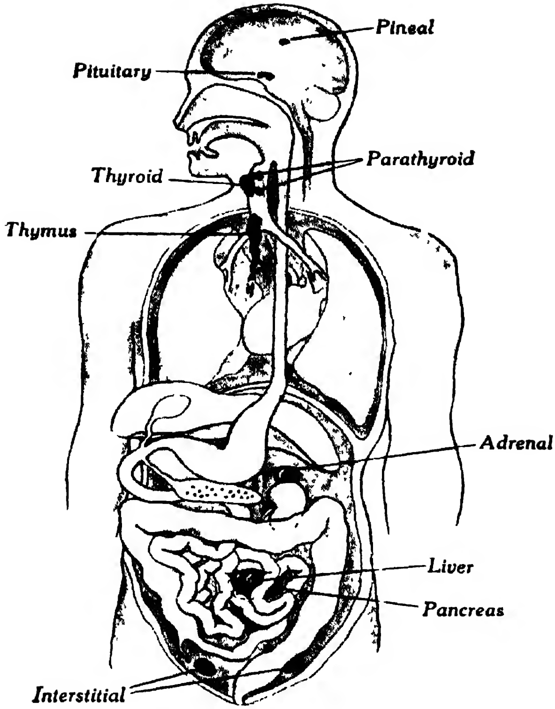

FIG. 22. The general location of the principal ductless (endocrine) glands

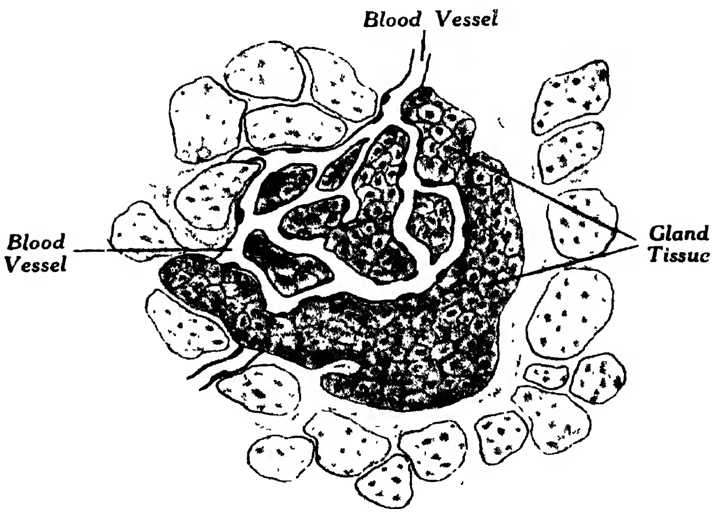

FIG. 23. Cross section of ductless gland (highly magnified).

The Pituitary Gland

This is a small body about the size of a pea, and it is attached to the base of the brain near its center. The gland has two parts, a front lobe and a rear lobe. The front lobe secretes a substance known as *tethelin* which appears to assist in keeping proper body temperature, and in maintaining balance or steadiness of the body, and also exercises some control over the growth, and thus the size, of the skeleton. Too much secretion, for example, results in one's becoming a giant, and too little in one's becoming a dwarf. If over-secretion occurs after growth is complete, the effects will appear in undue enlargements of particular parts of the body, such as hands, feet, nose, etc. Secretions from the rear lobe known as *pituitrin* help to control the action of the kidneys and mammary glands, and to maintain the tonus (partial contraction of a muscle which makes it respond more readily to stimulation) of the visceral or smooth muscles of the internal organs. Extracts from this part of the gland, when injected into the blood, will heighten the activity of nearly all of the internal muscles. This extract is given frequently to hasten childbirth. (3)

The Pineal and Thymus Glands

The functions of the *pineal*, which is located at the base of the brain in the frontal lobe, and the *thymus*, located in the chest near the lungs, are not well known. It is thought that they work together to hold sex development in check until the time of puberty. The pineal gland is of historical interest because it was thought by Descartes, a French philosopher, to be the seat or residence of the mind or soul of man. From this residence the soul or mind exercised control over the other parts of the body! (3)

Thyroid Gland

The thyroid gland consists of two elongated lobes, located one on each side of the windpipe and larynx. The secretion of this gland is called *thyroxin*. The compound is now manufactured in the laboratory for use by physicians. Thyroxin is vital to the function of the organism as a whole, as well as to its physical and mental growth and development.

If the thyroid gland is defective and fails to supply the body with the secretion, the result is a condition known as *myxoedema.* In this disease the skin dries, the hair falls out, body temperature is lowered, sex functions diminish, and the cells of the body tissues tend to atrophy or die. The person so afflicted is constantly in a condition of lethargy; he is difficult to arouse to action, and often falls asleep without any apparent cause. In such cases thyroxin is administered by mouth, and the treatment frequently brings about a decided improvement in the patient.

A thyroid which is defective at birth, or which becomes defective during the growth of the individual, results in *cretinism.* A cretin is a dwarf-like, poorly shaped individual, bordering on idiocy in intelligence. Among other effects, this condition results in arresting the growth of the body as a whole, in delaying the development of the sex organs, and in blocking the development of the cells of the cerebral cortex.

Over-secretion of the thyroid speeds up the body processes. The visceral organs over-act, and the body as a whole works too quickly. The person, likewise, suffers from great mental excitement, being easy to frighten even with the slightest sound.

Another condition associated with thyroid activity is that known as *goiter.* This is due to a lack of iodine in the system, and this deficient supply results in an enlargement and improper functioning of the thyroid. Goiter is prevalent in some sections of the country, due chiefly to the absence of iodine in the rocks and soil, and, consequently, in food stuffs. The disease is easy to prevent by supplying people with digestible iodine in salt and water. This is often done by salt manufacturing companies, and by city water companies. Iodine compounds are especially needed by growing girls between the ages of ten and sixteen. (1, 3, 6)

From the foregoing discussion it may be seen that the thyroid acts as a regulator of the whole body. It not only helps to control the growth of the bodily structures, but it also assists physical and mental functions.

Parathyroid Glands

There are four parathyroids, two embedded in each of the thyroids. Each is about the size and shape of a grain of wheat.

The chemical contents of the secretion have not been discovered. It is known, however, that the secretion is needed for the normal functioning of muscles and nerves. When the glands are removed, muscular tremors, or spasms, accompany efforts of the individual to move the limbs. The effect on the nerves of a lack of the secretion is to make the person highly excitable, restless, and sleepless. Relief from this condition is often brought about by injecting calcium salts into the blood and lymph. The result makes it appear that these glands are manufacturers of a hormone which regulates the lime supply necessary for the health and strength of bones, muscles, teeth, nails, etc. How the hormone does its work, however, is not known. The effects of over-secretion of the parathyroids have not been discovered. (1, 3, 6)

The Adrenal Glands

The adrenal glands are two flat, yellowish capsules attached one to each of the kidneys. The secretion is known as *adrenin*, a powerful drug-like substance which has a variety of effects on bodily functions. It increases heartbeat, blood pressure, lung action, action of the sweat glands, liver secretion, and the strength of the striped muscles. It appears to act on muscles both directly and through the nerves which innervate them. Adrenin decreases, inhibits, or blocks the activities of the stomach and intestinal walls, and the muscles of the iris (causing the pupil to dilate). The effect on the liver is that of causing greater amounts of blood-sugar to be released into the blood stream, and the latter is the substance which gives additional strength to the striped muscles. The presence of adrenin in the blood causes it to clot more rapidly than normal. Adrenin, for commercial purposes, is obtained from the glands of sheep, and is used by physicians to heighten the activities of the organs affected. The trade name of this preparation is adrenalin.

The effects of adrenin mentioned above have been discovered by careful experiments on animals, and by the use of the substance for medical purposes. It is believed, however, that the secretion is not present in the normal flow of the blood, as is the case with the secretions of other glands. It appears, therefore, that adrenin is held in reserve to be used in times of stress, as in

emotional excitement. It is known, for example, that adrenin is present in relatively large amounts in the blood of persons suffering from extreme fright or anger. Thus, at such times, the adrenals pour out their secretion to tone up the organism for violent action. The usefulness of the various changes produced in the organism at such times lends support to the belief. Ordinary observation reveals that persons can exercise greater than normal strength in times of excitement; that wounds received in a fight do not bleed as freely as wounds received during normal behavior; and that the other effects, such as the stopping of digestion, are present in emotional responses. (1, 3)

The Brain as a Reactor

The Thalamus

Nerve impulses originate in the receptors where they are taken over by sensory neurons and conducted to the spinal cord and brain. Upon reaching the spinal cord, impulses cross synaptic connections to ascending fibers which conduct them to higher levels such as the medulla, cerebellum, thalamus, and cerebral cortex. Nerve impulses which reach the cortex from the receptors, except the olfactory, pass through the *thalamus*, where synaptic connections are made with ascending fibers which spread out to all lobes of the cortex. In this manner the thalamus serves the function of collecting nerve impulses from the numerous receptors, and of distributing them to their proper centers in the cortex. Upon passing through the thalamus, nerve impulses seem to give rise to the conscious states we call pleasantness and unpleasantness. (7)

The Cortex

The cortex, as we have seen, is a mass of convoluted nerve tissue consisting mainly of a network of short, complicated neurons, which afford connections between its various parts. These neurons appear to be the reacting organs for all conscious states and processes, including sensing, perceiving, remembering, thinking, judging, and reasoning. How it performs these various functions is largely a matter of speculation, but there is a sufficient number of facts available to justify some theorizing.

SENSORY AND ASSOCIATION AREAS. The cortex has been divided into certain *sensory* and *motor areas.* A *sensory area* is a section of the cortex principally involved in a sensory function, such as seeing, hearing, smelling, and tasting. The various sensory areas that have been marked off are as follows: (a) visual, in the occipital lobe, (b) auditory, in the temporal lobe,

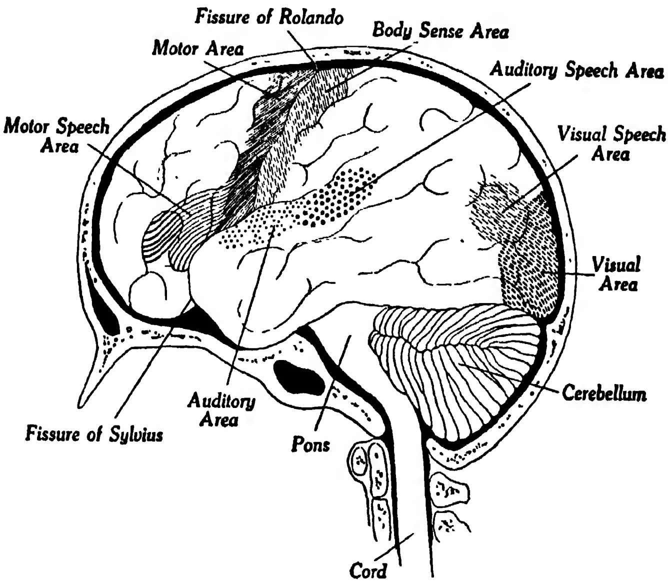

FIG. 24. Diagram showing the chief sensory and motor areas.

(c) cutaneous and kinaesthetic, in the parietal lobe, just back of the fissure of Rolando; (d) olfactory and gustatory, on the middle surface of the hemisphere in the frontal lobe. From the accompanying illustration of the brain (Fig. 24), it may be seen that most of the sensory areas are back of the fissure of Rolando. It is to each of these areas that nerve impulses come from the various receptors. Upon reaching a particular area, the impulses occasion a conscious experience, such as seeing, hearing, tasting, and smelling. Adjacent to, and surrounding each sensory area, is an *association area* composed of association neurons that are connected synaptically with the sensory fibers. Consequently, when an impulse reaches a sensory area, it can spread to adjacent areas and eventually to every section of the cortex. It is believed that the spreading of nervous energy over these areas

brings about such conscious processes as imaging, remembering, and thinking. (6)

These assumptions are made for the following reasons: (a) Injury of a particular sensory area will result in the loss of the function assigned to it. (b) Injury of association areas renders the individual unable to recognize, remember, or think about a particular object that he says he can see, hear, taste, etc. (c) Injury of the cortex as a whole renders the individual totally unconscious and thus unable to perform any mental function.

MOTOR AREAS. The frontal lobe of the cortex contains a number of *motor areas*. (See Fig. 24.) These are sections or areas that contain the dendrites and cell bodies of motor projection fibers. These fibers originate in the cortex but descend to different levels of the spinal cord where they make synaptic connections with other motor neurons going out to the muscles of the trunk and limbs. Most of the motor centers are found in the convolution immediately in front of the fissure of Rolando. Other motor areas located in the frontal lobe are those which contain the beginnings of motor neurons that end in the muscles of the head, eyes, and vocal cords. The latter center is known as the *motor-speech area*. The *visual-speech area* is located in the parietal lobe just back of the cutaneous-kinaesthetic sensory area. The motor areas are connected with the sensory areas by means of association neurons. It is these connections that enable the individual to act, move, speak, write, etc., as well as to see, hear, and think, when a given stimulus is presented. For example, if one were to see an orange such an experience would involve the visual area. In order to recognize the orange the association area adjacent to the sensory area, and possibly association fibers running to the gustatory, olfactory, and tactual areas would be involved. To speak the word "orange" would involve the visual-speech, auditory-speech, and motor-speech areas. If one were to reach for the orange, this movement would involve certain portions of the motor area in the frontal lobe. Thus a very simple reaction appears to involve many different centers at or near the same time; and this fact implies that the cortex ordinarily functions as a whole, even in the simplest types of behavior.

Further evidence of the belief that the cortex functions as a whole has been brought out in a number of observations and

experiments. During the World War soldiers who received brain injuries were observed to suffer the loss of some function, such as seeing, hearing, or moving; but after a lapse of time, they would often regain the lost function. Moreover, persons paralyzed have been retrained to walk and to use their arms and hands. Rats, trained to run a maze, will, after additional training, regain lost functions due to brain injuries inflicted by operations. These observations indicate (a) that one part of the brain is sometimes capable of taking over the functions formerly performed by another part; and (b) that complex functions are the effects of activities of widespread areas of the cortex. (7)

The theory just set forth is known as the *theory of vicarious functioning of the cerebral cortex.* It has been proposed as an opposing theory to the doctrine of the phrenologists and faculty psychologists presented in Chapter I.

EXERCISES

1. Read the chapter and then list the specific classes of organs included under the following headings: (a) receptors, (b) connectors, and (c) reactors.
2. Distinguish between sense organs and receptors. How many senses does man have? Name them.
3. Indicate the nature and characteristics of nerve impulses.
4. Combine the various classifications of receptors into a general table, using as main heads the following: (a) exteroceptors, (b) proprioceptors, and (c) interoceptors.
5. Make an outline of the human nervous system, showing the main parts and sub-divisions.
6. Make diagrams of the different types of neurons, labeling each part of each type.
7. Describe the function of each part of each type of neuron.
8. Make an outline sketch of the brain and indicate on it the four lobes and the sensory and motor areas in each lobe.
9. Why is the cortex usually thought of as the reacting organ for conscious experiences?
10. How would the teaching of individuals differ from the present methods if the cortex had definite areas performing distinct functions?
11. Make a table showing the name, location, secretion, and principal functions of each of the ductless glands.
12. In what respect is the musculature of human beings different from that of lower animals? How do these differences correspond to differences in behavior?

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CHAPTER V

GROWTH, DEVELOPMENT, AND MATURATION

GENERAL CHARACTERISTICS

Introduction

In the previous chapter, an effort has been made to describe the organs which are involved in the performance of various functions. While the description is somewhat brief and inadequate for a thorough understanding of behavior, the reader has probably grasped the fact that the character or nature of any act of behavior is determined by the nature and condition of the structures involved in performing it. In this chapter, we shall study the condition of various structures at different stages in life by calling attention to their growth, development, and maturation. The reason for studying these processes is the fact that behavior varies with them. That is, the effect of any given stimulus on the individual depends to a large extent on the age of the individual. This is true because the different structures undergo such marked changes with age that the individual reacts differently. For example, a newborn infant reveals relatively few functions, compared with the adult, because of the undeveloped condition of the physical structures. As this condition improves, by means of certain changes that take place in the structures, we should expect not only an improvement in the capacities and functions that the human infant can perform, but also the appearance of new capacities and functions. An effort will be made, therefore, to indicate the nature of these changes and to discuss some of the factors that account for them.

Definition of Terms

The changes that take place in the human being are described by three terms: (a) growth, (b) development, and (c) maturation. Let us note the meanings and applications of these terms.

Growth

The term *growth* describes three things: (a) increase in the size and weight of a given organ, (b) cell division, and (c) increase in the amount of particular capacities. Because they are endowed with the capacity of subsisting upon environmental factors, all living cells grow by taking in food and oxygen and throwing off waste products. When an individual cell reaches a certain size, its outer surface becomes too small to secure food and oxygen and throw off wastes fast enough to grow further. At this point, a cell divides, causing an increase in the number of cells and in the size and weight of the organ of which they are the parts. The technical term for cell division is *mitosis*, a very complex process which we do not need to study at this point. (2)

Development

Not only does an organ increase in size and weight, but it also undergoes marked inner changes. As the brain, for example, increases in size and weight, it likewise increases in complexity. The brain cells, in particular, send out branching processes which form new synapses, and the cells acquire more mature forms. These changes may continue long after the brain has attained its full size and weight. Similar changes also occur in muscles, bones, teeth, and soft tissues. Moreover, as such changes go on, the particular organs in which they occur, and the organism as a whole, gain greater capacity to function in increasingly complex ways. That is, as an organ increases in complexity, its functions undergo corresponding changes in the direction of greater facility and efficiency of performance. All of these changes in structures and in functions are designated by the term *development*.

Maturation

The term *maturation* is used in psychology with two meanings: (a) To designate the final stage at which a given trait has reached its maximum growth and development. Structures, such as the eye, brain, or a given muscle, for example, are mature when they cease to increase in size and to change within. Functions, such as reflexes and instincts, are mature when the

pattern of movements ceases to change and becomes relatively stabilized. Capacities are mature when they reach a stage at which they remain constant in amount. (b) Since functions and capacities depend upon the stage of growth and development attained by various structures, the term maturation is used to designate the process by which sensori-motor connections attain maximum growth and development. These connections, it may be recalled, include receptors, essential neurons, and reactors, or systems of these elements, present and ready to function. At first, the structures may be so undeveloped that they are incapable of performing particular functions. Then comes a period of growth and development, during which the organs begin to integrate so that function or activity is possible. Eventually, the organs are mature enough for a particular function or activity to appear in recognizable but more or less chaotic form. Finally, the organs reach a stage in growth and development at which the function or capacity remains fairly constant in pattern and amount. When this stage is reached, the function or capacity is mature. The organs may continue to grow, of course, making it possible for other modes of behavior to appear. When all growth and development have stopped, then the organism has reached maturity.

Significance of Maturation in Education

Physical growth and development, and the consequent maturation of traits, are among the most significant factors that an educator should take into account in dealing with the child. This is true because these processes are intimately bound up with everything the child does. In the first place, maturation helps to account for the appearance of inherited traits at stages in life other than infancy. As the child grows and develops, and structures mature, new forms of behavior appear that are not explainable in terms of environmental factors. Moreover, until maturation has taken place, it is impossible to bring about many desirable patterns of acquired behavior, even though we may make serious efforts to do so. It is impossible to develop the skill of handwriting, for example, until the sensori-motor elements are sufficiently mature to undergo the necessary modifications. In spite of this fact many parents and teachers try to get children to do things they are not ready to undertake. It is

also possible to spend considerable time trying to get young children to acquire various forms of behavior that will appear, in the course of time, as a result of maturation, without teaching or training. Too, efforts may be made to improve capacities and functions that cannot be improved because of inherited limitations. All of these matters, and others that might be mentioned, are definitely related to the processes of growth and maturation. (5, 8)

In the second place, as we shall see later, all individuals do not mature, in a variety of particular ways, at the same time. This fact results in an endless variety of problems related to individual differences that teachers need to understand and appreciate. In the pages that follow reference will be made to such problems and to many of the factors that underlie them.

Stages in Human Life

Stages Outlined

At some time in the past, there originated the custom of calling individuals by names which indicated their stages of development. Such names as infants, babies, children, and young people still persist not only in everyday speech but also in psychology. For the sake of clarity in future discussion, we need to give such names a definite meaning in each case by marking off the ages which they describe. An effort has been made to do this in the stages named and listed below. The ages, school grades, and types of education usually associated with each of the stages are likewise shown. (8)

I. *Fetal Stage*, fertilization to about nine months, embryological growth, formation of bodily organs, prenatal stage.
II. *Infancy*, birth to about one year, dependent stage.
III. *Childhood*, one to twelve years.
   A. Babyhood, one to two years, home training.
   B. Early Childhood, three to six, nursery school and kindergarten, preprimary.
   C. Middle Childhood, six to nine grades 1, 2, 3, primary, elementary school.
   D. Later Childhood, nine to twelve, grades 4, 5, 6, intermediate, elementary school.
IV. *Adolescence*, twelve to eighteen, grades 7, 8, 9, 10, 11, 12, secondary school.

- A. Early Adolescence, twelve to fifteen, grades 7, 8, 9, junior high school.
- B. Later Adolescence, fifteen to eighteen, grades 10, 11, 12, senior high school.

V. *Youth*, eighteen to thirty, maturation relatively completed.
- A. College group, eighteen to twenty-two, freshman, sophomore, junior, senior.
- B. University group, twenty-three and over, graduate.
- C. Mixed groups, specialization period.

VI. *Maturity*, thirty to sixty, adult stage, social servant.

VII. *Senility*, sixty to seventy, or to death, old age, retired servant.

This description indicates that an individual begins as a fetus, is born an infant, becomes a child, goes through a period of transition during which he is called a lad or adolescent, becomes a youth and develops into an adult or mature person, reaches old age, and finally dies. There are no sharp lines of distinction or division to be drawn between any two stages, because there are numerous variations among individuals as well as between the sexes. For this reason, we have an overlapping of a year between each stage. The description also shows that during the course of life, society has established a relatively formal training that each individual is expected to receive. He is first trained in the home where he is entirely dependent upon the parents. Then he is taken to the nursery school at about age three, and remains there until he is ready for the kindergarten. From the kindergarten he goes to school, entering the primary grades, passing to the intermediate grades, going on to junior high school and eventually to senior high school. From there he goes to college or takes his place in society to follow a vocation. If he finishes college he may become a graduate student in a university. When he takes a highly specialized type of training, he is graduated from his formal training. He reaches maturity and is then ready to participate in the affairs and activities of adult life. After a period of thirty or forty years of active service, his powers and capacities begin to decline, and his physical mechanisms fail. At this time, he retires from active service, usually becomes dependent upon others, and eventually dies.

A study of these stages, the names given to them, their relation to school periods, and the names of these school periods will be helpful to the student in understanding fu-

ture references that may be made to the development of the individual.

Methods of Studying Growth and Development

Structures

The growth and development of bodily organs are studied in a variety of ways. Growth, its amount and rate, is studied by taking measures of the size and weight of particular organs, as of the whole organism, at different ages or at regular intervals. Most frequently, measures of a large number of individuals of different ages are made, and *norms* or averages are calculated for the different ages. By noting the differences between the averages for the various ages, the rate of growth can be determined for any particular trait; and by noting the variation of particular measures from the average, the developmental status of a given individual may be estimated. That is, an individual is under- or over-size when his height and weight are below or above the norm for his age. The best norms, however, are not those derived by measuring individuals of all the different ages; but they are those based on measures of the same group of individuals at different ages. That is, the same or similar measures are made at regular intervals of the same individuals. This method has many practical difficulties in that it is often impossible to find the same individuals, or even their previous records, year after year over a long period of time.

The development of structures is studied by special examinations of particular organs at different ages. Brain development, for example, is studied by making microscopic examination, and by noting the effects of various drugs on nerve tissue. Examinations of teeth, bone structure, such as the bones of the wrists, and muscle fibers of individuals at different age levels, have yielded much valuable information regarding the development of these structures.

Maturation of structures can be inferred, of course, from the measures used in studying growth. When measures made of organs at different ages fail to show an increase in size and weight, or when careful examinations show that no further development is taking place, the organs are assumed to have reached maturity. (2)

Functions and Capacities

The growth, development, and maturation of functions and capacities are determined by testing individuals at different ages. The nature of the tests, or other measuring devices, depends, of course, on the nature of the function or capacity under observation. The most useful instruments for making specific measurements are those developed by experts interested in particular functions, such as the instruments used by a physician or by an optometrist. The most useful measures employed for determining intellectual and motor development are the standardized tests described in Chapter I and Part IV.

In our future study of functions and capacities, descriptions of particular devices will be presented, especially when such descriptions are necessary to make clear the nature of the function or capacity under observation. The fairly constant use of norms in the field of education, in educational psychology, and in the classroom bears testimony to the importance of measuring devices and of growth and development.

Heredity, Environment, and Growth

Hereditary Factors

Why do living things grow, develop, mature, stop growing, and die? This is an old question which has never been answered satisfactorily. All we can say is that these processes are fundamentally the unfolding of innate predispositions and potentialities. We know only that as soon as a living cell is deposited in an environment which furnishes the proper essentials, it begins to grow and develop. After a period of time, if given nourishment and surrounded by proper environmental factors, the living organism reaches maturity. This is a fairly constant status, in terms of size, weight, and internal construction, with only a few fluctuations, during which the organism is producing and preserving its kind. All this is a universal process, among living things, to which all of the factors of heredity contribute—the species, race, lineage, and parentage. (5)

Environmental Factors

The fundamental elements basic to growth, development, and maturation consist of a medium or place to exist, food, air,

water, and shelter. Without these there could be no organism. The medium or place of existence must be suited to the natural propensities of the organism; the food and water must contain the proper ingredients to prevent malnutrition; the air must contain a sufficient amount of oxygen; and the shelter must protect the organism from such severities as extreme climatic conditions, accidents, diseases, and shocks. Furnished with these conditions, the organism must react in vital ways: it must breathe, eat, drink, sleep, exercise, and rest. As a stimulus for each of these forms of behavior, however, nature has provided a strong tendency in each individual. When provided with essentials, even in bare and rugged form, the living organism survives and follows the universal processes decreed by heredity.

Though we are able to enumerate the environmental factors essential to survival and growth, we do not understand the operation of the factors that determine its nature, rate, amount, and limit. All we can do is to observe the processes, secure data concerning them, and state certain principles which describe our data.

General Principles of Growth and Maturation

The factors which influence physical growth and development are so consistent that it is possible to formulate a set of principles or *laws of growth* which describe these processes. The following appear to be the most significant ones: (a) Growth is irregular, each organ having a different rate of increase; the growth curve for the brain, for example, will differ somewhat from one for the growth of the skeleton. Moreover, general physical growth proceeds at an irregular pace, being more rapid at certain periods than at others. (b) Some organs maintain a rate of growth in harmonious proportion with the growth of the body as a whole. This is true of the bones and muscles. Other organs, however, grow rapidly and stop, maturing at an early age; and still others have a long period of slow growth and reach maturity late in life. (c) Organs most nearly mature at birth reach maturity earlier than those that are less mature and are less influenced by intrinsic factors than are the less developed traits. (d) Individuals differ in the rate of growth and in the levels of maturity attained, but these differences tend to remain about the same during the total period of growth and development. A tall individual at infancy, for example,

remains relatively tall throughout life; or a short infant usually becomes a short man or woman. (e) The growth of a particular organ in a given individual tends to maintain a relatively constant relation to the growth of the same organ in other in-

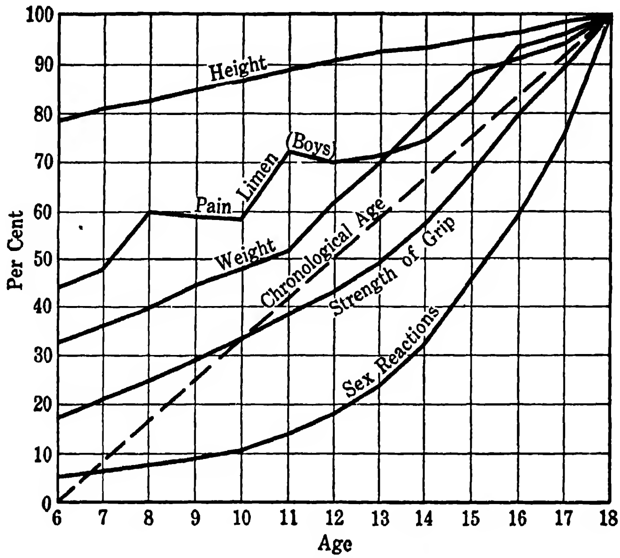

FIG. 25. Showing various curves of growth, beginning at age 6 and continuing to age 18.

dividuals so that growth curves for various individuals tend to have the same general form. (f) Irregularities in the growth of a particular person or organ are more likely to be caused by environmental than by hereditary factors. By "irregularities" is meant any unusual fluctuation or variation in the size, weight, or developmental status of that person or organ when such irregularities are not observed in the growth and development of other individuals. Such irregularities are most frequently due to inadequate sunshine, improper feeding, diseases, infections, etc. With an environment free of irregularities, as noted above, heredity tends to conserve individual similarities and differences at all stages in life. (11)

EXAMPLES OF PHYSICAL GROWTH

As examples of the manner in which the foregoing principles operate, attention will now be concentrated (a) on the growth

of the human organism as a whole, and (b) on the growth of particular groups of organs at different age levels.

The Growth of the Organism as a Whole

A total picture of the growth of an individual may be obtained by noting the average height and weight of many individuals taken before and after birth at different intervals.

Prenatal Growth

The human zygote, when first formed, is about 1/250 cubic millimeters in volume, and weighs about 6/1000 grams. At birth, the infant has a volume of about 3½ million cubic millimeters, and weighs about 3200 grams. This means an increase of more than one billion times the original volume, and an increment of about 500,000 per cent in weight. The height of the individual is approximately zero at the start and about 20 inches at birth. This increase in size and weight is accompanied by many and varied types of development. During this stage all the different organs take form, so that by birth they are all present in recognizable form, and many of them are ready to start functioning. This prenatal rate of growth and development is vastly greater than that occurring during any other stage.

The rate of growth and development maintained during the prenatal stage depends, in part, upon conditions of the environment of the fetus, but chiefly upon hereditary factors. This environment includes not only the womb, in which the fetus resides, but it also includes any factors which may affect the fetus from without. While protected from most external influences, the fetus may be affected in a variety of ways. Biologists point out, for example, that anything which can bring about a chemical change in the content or character of the mother's blood stream will affect the growing fetus. This is because the organism is, at this time, wholly dependent on the blood stream of the mother—for growth, development, and life itself. Some of the things that affect the child in this manner are malnutrition, fatigue poisons, some diseases (syphilis, alcoholism, and possibly typhoid fever), overwork, mental or physical strain, and worry on the part of the mother. Some of these factors seem to bring about changes in the mother's endocrine

glands, and some seem to affect the nourishing qualities of her blood, thus affecting the growing fetus.

There are some popular beliefs in certain "prenatal influences" with which the biologists do not agree. These are beliefs that certain experiences of the mother, like the sight of snakes, deformed persons, etc., cause the child to have birthmarks that resemble the causes of the experiences. Biologists also disagree with the popular notion that the occupations of the expectant mother, such as studiousness, practice of music, fancies, and devotional exercises, predispose the child to be studious, musically inclined, religious, etc. Birthmarks may be caused by defective genes, accidents, or adhesions. Whether the child is studious, musical, imaginative, or religious depends upon hereditary factors and training. These popular beliefs are based on superstition; they are "old wives' tales" passed from one generation to the next. Since the only connection between the fetus and the mother is furnished by the placenta, it is impossible for any of the physical and mental activities of the mother to affect the child, except those that affect or modify the nourishing qualities of the blood stream. If the mother is properly cared for, and conducts herself in a reasonable manner, she need have no fears regarding the effects on the expected child of what she feels, thinks, imagines, or sees. What the child's hereditary traits will be is determined at the moment of fertilization.

If the prenatal environment is *normal,* that is, free of such harmful factors as those suggested above, prenatal growth and development will take place at a rate, and will follow the directions, that hereditary factors determine. That is, the processes of fertilization will go on; cell divisions will take place; the genes will unfold in serial order to form the different organs; and a general pattern of development will be followed. Every organ, in brief, will take form at the appointed time, and at the proper time the organism will be born. (2, 5, 6)

Post-Natal Growth and Development

Growth after birth is relatively slow, compared with prenatal growth; but is more rapid during the early than during the later stages. For example, the increase in weight is about 23 per cent during the first month and only 2.8 per cent during the

twelfth. The average height of boys is about 42 inches at age five and about 68 inches at age eighteen, an increase of about 62 per cent. These increases are much less than those during the prenatal stage.

A total picture of the growing individual from age five to eighteen may be obtained from the data below.[1] These show the height of boys and girls of different builds by ages, and the expected gain in weight per year for each type.

								Boys						
Age		6	7	8	9	10	11	12	13	14	15	16	17	18
Average Height (inches)	Short	43	45	47	49	51	53	54	56	58	60	62	64	65
	Medium	46	48	50	52	54	56	58	60	63	65	67	68	69
	Tall	49	51	53	55	57	59	61	65	67	70	72	72	73
Average Annual Gain (lbs.)	Short	3	4	5	5	5	4	8	9	11	14	13	7	3
	Medium	4	5	6	6	6	7	9	11	15	11	8	4	3
	Tall	5	7	7	7	7	8	12	16	11	9	7	3	4
								Girls						
Age		6	7	8	9	10	11	12	13	14	15	16	17	18
Average Height (inches)	Short	43	45	47	49	50	52	54	57	59	60	61	61	61
	Medium	45	47	50	52	54	56	58	60	62	63	64	64	64
	Tall	47	50	53	55	57	59	62	64	66	66	67	67	67
Average Annual Gain (lbs.)	Short	4	4	4	5	6	6	10	13	10	7	2	1	0
	Medium	5	5	6	7	8	10	13	10	6	4	3	1	0
	Tall	6	8	8	9	11	13	9	8	4	4	1	1	0

The data for the boys show a gradual, regular increase in height of about two inches per year, except between ages fourteen and fifteen when there is an increase of two inches, and between ages sixteen to eighteen when the increase is one inch per year (data for medium build). The weight of boys increases irregularly showing the greatest increase between twelve and sixteen. The height of girls is reached at the earlier age of sixteen, there being little increase afterwards. The weight of girls increases steadily to age ten. From age eleven to thirteen the increase in weight is much greater, but there is little increase in weight after age sixteen. Thus boys get their growth later than girls, and grow more rapidly at different ages, when height and weight are both considered.

This increase in total size is due, of course, to an increase in

[1] From Baldwin.

the size of many different organs and parts of the body. The total picture fails to illustrate the more subtle aspects of growth, especially of various organs, and it fails to indicate the types of development which are occurring in the various organs. It also fails to show the degree of maturation at different ages. Attention will therefore be given to these different types of structures.

The Growth, Development, and Maturation of Body Parts

Growth and Development of the Skeleton

The energy for general physical growth seems to reside chiefly in the skeletal tissues or bones. At birth the weight of the skeleton is about 13 per cent of the weight of the whole body. At maturity it is about 23 per cent of the body weight. The skeleton increases in general size, of course, in proportion to the height and weight of the individual. Development of the skeleton consists mainly of the fusion of bones, and in the consequent decrease in the number of bones observed at birth. The lower or sacral part of the vertebrae, for example, has five bones at birth which unite to form the sacrum in the adult; the tip of the spine begins as four bones which fuse into the coccyx; and the three bones of the pelvis fuse into one to form the base of the trunk. Another phase of development of the skeleton is the proportion of different parts. The infant, for example, is largely trunk and head, his limbs being relatively small. During childhood there is an increase in leg length over trunk length which reduces the weight of the head and trunk together from 68 per cent of the total at birth to about 52 per cent in the adult. These changes occur most rapidly in boys between ages twelve and fifteen and in girls between ages ten and thirteen. This period of rapid growth, because of the drain upon the energy output of the vital organs, is often one of high fatigability, mental slowness, lowered resistance to diseases, and general "laziness." Various other changes are taking place, however, which contribute to these characteristics. (2)

Development of the Vital Organs

The growth of the skeleton is accompanied by a corresponding growth in the vital organs. The organs of digestion, respiration,

circulation, and excretion grow at a rate proportionate to the needs of life and behavior at different ages. The growth of the heart is gradual, its total volume at maturity being about double that which it was at birth. The amount of blood likewise increases in proportion to the needs of the system as a whole. The arteries and veins increase in size less rapidly than the heart, causing a gradual increase in blood pressure with age. The lungs seem to grow faster than the trunk, especially at puberty (adolescence) when there is a marked increase in lung capacity and in the area of lung tissue. The rate of respiration decreases from 35 to 44 per minute at birth to 18 to 20 per minute by the age of fifteen, remaining fairly constant during the remainder of life. The digestive tract exhibits marked changes during the course of life. The muscular contractions of the stomach are weaker in childhood than at maturity; the small intestines increase in capacity threefold; and the large intestines increase fourfold between the ages of six and twenty. The digestive juices for some months after birth are lacking in the power to dissolve plant and animal foods. All of these changes, of course, require great care in the selecting and preparing of foods at different ages, and in guarding and protecting the individual against different diseases. (2)

Maturation of Sense Organs

Sense organs, as previously implied, mature at an early age. Studies of the ability of infants to respond to visual, auditory, gustatory, tactual, and other sensory stimuli indicate that most of the sense organs are almost mature at birth. It is believed, however, that they undergo various changes during the first two or three years, and approach their final stages of maturation by age four. In this we find the earliest forms of maturation. Complex functions depending upon other structures have to wait until these other structures develop and mature. (2, 5)

Development of Muscles

The muscles undergo various changes beginning before birth and continuing to thirty or forty years of age. The muscles taken together increase from 23.4 per cent of the total weight at birth to 45 per cent at the age of twenty-six. After age forty-

five the percentage of weight shows a decline. The period of most rapid increase in the weight of muscles is between ages fourteen and sixteen. Accompanying the increase in weight, of course, is an increase in the thickness and size of the muscles. The elasticity of the muscles does not increase, but rather diminishes from birth on, and there is also a decrease in the water content of the muscles. The larger muscles, such as those in the arms and legs which move the great joints, develop before the finer and smaller muscles, such as those of the fingers, throat, and lips. (2)

Changes in the Glands and in Their Effects

In our previous discussion of the structures and functions of the glands attention was called to the part played by the endocrines in the growth and behavior of the organism. It may be said here that there is hardly a gland that does not affect growth and development in one or more vital ways. The glands most closely associated with growth, it seems, are the pituitary and the thyroid. The pituitary gland appears to regulate the growth of the skeleton, particularly the size and length of the bones; and the thyroid regulates the growth of the soft tissues. Deficiencies in their secretions will not only stunt the growth of the structures but will also cause shifts in body proportions.

Not much is known regarding the changes which occur in the glands themselves, but some appear to increase in size and to increase their effects with increase in age. The thymus gland retains up to puberty the size with which it begins at infancy, and after puberty it decreases in size and finally disappears. The pineal gland grows and develops through the seventh year, when it seems to mature and to assume some of the functions previously performed by the thymus. These functions include the checking and regulating of the thyroids and reproductive glands. At least, deficiency in pineal action is accompanied by rapid and precocious sexual, physical, and even mental development. The parathyroids, as previously indicated, are instrumental in bringing about the proper development of bones, nerves, and teeth, through supplying a secretion which makes it possible for the organism to manufacture the lime salts necessary for the health and growth of such organs. The sex glands, gonads, and reproductive glands, assume their major functions

at puberty. Previous to this time they have been held in check by the pineal and the thymus. These checking effects result in a more gradual development of the glands, which enables them to reach maturity at the same time as the sex organs. At puberty the sex organs and glands undergo rapid changes which prepare the individual for reproduction. This period occurs in girls around the ages of eleven to thirteen, and in boys around the ages of thirteen or fourteen, there being numerous individual differences in age.

These physical changes are accompanied by many important functional changes which have been the subject of much discussion among educators and psychologists.

As previously noted, the functions of the various glands are inter-dependent, so that it is practically impossible to isolate the function of any one gland. The essential condition of these organs to insure the proper growth and development of the organism and its various tissues is a proper balance of their functioning. When such a balance is not maintained, numerous irregularities are certain to occur. But the proper balance of the glands is largely determined by hereditary factors, and may be characterized as a tendency of the various glands to regulate and check each other.

The foregoing tendency is uniform among different individuals, in a general sense, but varies with the different glands during particular stages. It would appear, then, to be possible to characterize the different stages in life according to the gland which slightly dominates the others. Infancy, for example, may be described as the epoch of the thymus gland, which fundamentally inhibits and checks the other endocrines until the organism is sufficiently mature to assimilate properly their secretions. Childhood, on the other hand, is the epoch of the pineal gland which takes over the functions of the thymus but appears to check only the sex glands, leaving the thyroids and pituitary greater freedom. Adolescence is the epoch of the gonads and reproductive glands, which bring the individual to sexual maturity and dominate his life and traits in many important respects. Maturity is the epoch of general glandular stability, during which the glands have matured and have assumed a relatively permanent role in regulating the numerous bodily functions and behavior traits of the individual. Senility, finally,

is the epoch of glandular deficiency. During old age nearly all of the glands seem to be deficient in various respects, and this deficiency helps to bring about the general deterioration of the structures and functions of the individual. (2, 5, 8, 11)

Development of the Nervous System

The nervous system is the last of the organs of the body to reach maturity, but among the first to attain its final growth. After growth has ceased the various parts of the nervous system undergo several types of development which are basic to numerous functions. We shall notice growth first and the maturation processes later.

Growth of the Brain

The brain grows very rapidly during the fetal period, and possesses at birth about one-fourth of its final weight. It increases two or three times its weight during the first year, 10 per cent the second, and about 10 per cent the third, so that by the middle of the fifth year it has reached about 90 per cent of its final weight. Almost all of the remaining 10 per cent is attained during the next ten years; so that there is very little change in brain weight after age fifteen. When old age sets in, the brain begins to lose weight. The loss is due to a decrease in the water content, and to the destructive processes going on in the supporting tissues and myelin sheath.

THE CORTEX. The most significant change in the brain is not in its weight, but in the cortex and cell structure. The surface of the brain at birth and up to the fifth week is relatively smooth, but after this time its size appears to increase faster than the surrounding skull, and it forces itself into folds or convolutions. The crowding effect is relieved by further growth of the brain from front to back, the frontal lobe being the last part to develop. These changes seem not to be due to an increase in the number of the nerve cells, but to an increase in their size and length. The layer of cortical neurons is about two-thirds as thick at birth as that of the adult brain, and the cells themselves are particularly undeveloped and lacking in adult characteristics. Many of these cells remain undeveloped up to thirty or forty years of age, and some possibly never develop. (2)

Myelination. An important phase of maturation in the nervous system is the myelination of the neurons. As previously stated, myelination is a process by which the axons of neurons are gradually covered with a medullary or myelin sheath, a translucent, fatty covering which grows around nerve fibers apparently to insulate them from one another and to prevent nerve impulses from affecting parallel axons. The sensory and motor neurons which make direct connections in the spinal cord are myelinated first, at birth, making possible the simplest activities. Soon after birth the projection fibers originating in the sense organs and ending in the cortical centers are myelinated. This seems to make possible the early use of the sense organs. Then the fibers which connect the lower levels of the nervous system with the upper levels, the connecting neurons, receive their myelin sheaths. As these cells become myelinated the organism becomes increasingly capable of complex muscular activities, particularly when the cells connecting the motor centers of the cortex with the lower motor centers are myelinated. The last nerves to become myelinated are the association fibers of the cortex which connect the various sensory centers and the different convolutions. Myelination of these fibers, together with the growth and development of their end brushes and dendrites and other collaterals, continues until thirty or forty years of age. The most marked stage in all this growth and development is from eighteen to twenty years of age. The association fibers in the temporal and parietal lobes develop ahead of those of the frontal lobes whose fibers are the last to reach maturity. When old age arrives the destructive processes mentioned above begin, and the total cortex shows inner deterioration. (8)

Effects of Environment on Growth, Development, and Maturation

The effects of environment on prenatal growth and development were indicated above. Here we noticed that only severe abnormalities seem to influence the rate of growth and development. At birth, however, the environment of the individual is radically changed. The individual begins to breathe and exercise other vital functions; the sense organs are impinged upon by countless stimuli; and the infant is subjected to a large variety of experiences.

EXERCISES

1. Notice the distinction between *growth, development*, and *maturation*, and make a list of the specific changes implied by each term.
2. What justification is there for dividing the life span into distinct periods? What are the objections to the practice?
3. How are changes in structures, capacities, and functions studied?
4. To what extent are hereditary factors responsible for structural and functional changes?
5. Of all the changes that take place in body parts, which seems to be most significant from the standpoint of: (1) health, (2) education?
6. Make a table showing the glands which function dominantly at different ages.
7. What functions and capacities appear, develop, and mature with the myelination process?
8. What are the significant structural changes that take place during senility?
9. School systems differ in organization. The 7-4 plan has eleven grades divided into elementary and secondary schools. The 5-3-3 plan has eleven grades, with elementary, junior high, and senior high schools. The 6-3-3 plan has twelve grades with elementary, junior high, and senior high schools. From a study of the chapter show why one of these plans rather than the other two should be followed.
10. Discuss the statement: "A person who grows slowly in one trait usually grows rapidly in an opposite trait."

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CHAPTER VI

AN INVENTORY OF INHERITED FUNCTIONS AND CAPACITIES

INTRODUCTION

Purpose of the Chapter

The purpose of this chapter is to present an inventory of inherited *functions* and *capacities.* In doing this, various classifications and examples of traits that seem to be inherited will be presented. The guiding principles followed in selecting particular traits as native are the criteria set forth in Chapter III. The selection of terms applied to various classes has been based on a study of the meanings attached to them in current usage.

Here, then, the student is not only presented with the problem of getting acquainted with inherited functions and capacities but also with that of learning the meanings of terms used to describe them. In subsequent chapters, the traits of greatest significance to educators will be described in more detail.

General Classification

A convenient way of thinking about inherited traits in general is to consider them as belonging to three general classes: (a) motor activities; (b) conscious or mental states and activities; and (c) capacities. Each of these groups will now be discussed.

MOTOR ACTIVITIES

Classification

By "inherited motor activities" is meant muscular movements or patterns that appear in the individual apart from the influence of environment, previous experience, or training. These activities are usually divided into two classes: (a) re-

flexes, and (b) instincts; and each of these may be sub-divided into *visceral* and *somatic* functions. (1)

Reflexes

The Reflex Arc

The simplest arrangement of bodily and neural structures involved in an objective response to a stimulus includes the following: (a) a receptor and a sensory neuron, (b) a synapse, or functional connection, (c) a motor neuron and a reactor. This group of organs, considered as a functional unit, is known as the *reflex arc* or *reaction unit.* It is called an "arc" because the arrangement of the organs completes the circuit for the transmission of nervous energy from a receptor to a reactor. It is called a "reaction unit," first, because the reaction is the simplest type observed in human beings; and second, because it is believed by some psychologists that all complex forms of behavior can be analyzed into this type of reaction. (7)

Meaning of Reflex

The term "reflex" is applied to a variety of relatively simple functions whose *connections are made chiefly in the spinal cord.* The stimulus for any particular reflex is always a definite force or event, and the response is usually a prompt movement of a single reactor or a relatively small number of reactors. The complete reaction, moreover, is automatic in character, occurring apart from any conscious effort of the individual, and even despite his efforts to control it. Nearly all such reactions are present in infants in serviceable form, and they continue to function in essentially this same form throughout life, without being radically modified or changed by experience or training. Each separate reflex process acts as a protective, eliminative, or defensive reaction.

Types of Reflexes

Reflexes are either *visceral* or *somatic.* *Visceral* reflexes are the many specific reactions that occur in the viscera or body cavity. There is a group of reflexes belonging to each of such processes as respiration, circulation, digestion, and secretion. In digestion, for example, the following may be mentioned:

food taken into the mouth serves as a stimulus for the salivary secretion; when taken into the esophagus, the food stimulates the swallowing mechanism; the food upon reaching the stomach stimulates the opening valve; the presence of the food in the stomach occasions the release of other secretions and the churning movements of the stomach walls. Each specific reaction is a reflex. Under ordinary conditions, the visceral reflexes are stimulated by internal substances, events, or objects, and they perform their functions more or less independently of stimulation from the external environment. All these processes, being the activities of smooth muscles, or glands, are due to innervations through the autonomic nervous system. This system, by means of accelerating and inhibiting nerves, regulates all visceral processes by maintaining a kind of balance among them. For example, if the heart beats too fast, as a result of an accelerating impulse, its motion will be checked by means of an inhibiting impulse. (1)

Somatic reflexes are those that are stimulated by external forces or events and that involve the movements of the striped muscles. These include the following: (a) adjustments of the eyes, such as pupillary contraction and dilation, convergence, blinking, and specific eye movements in response to unusual or sudden changes in surrounding objects; (b) eliminative functions, such as sneezing, coughing, and yawning; (c) feeding activities, such as sucking, mouthing movements, tongue movements, and swallowing; (d) vocalizations, such as cooing, gurgling, and other simple sound performances; and (e) grasping, such as with hands and toes. (10)

Development of Reflexes

Attention has already been called to the fact that reflexes are present and relatively mature at birth. They seem to undergo few changes in their performances, except that the growth of the organism tends to make them stronger. The delicate visceral organs, especially, become increasingly capable of taking care of the needs of the body through strengthening specific reflexes. Nevertheless, the individual's equipment of reflexes, except for a few associated with reproductive functions, appears to be quite complete at birth. Consequently, we infer that all such functions are inherited.

Instincts

Definition and Description

The term "instinct" indicates a relatively complex pattern of activity that (a) appears in the individual of a given species apart from the influence of previous experience or training; (b) has a definite nerve center; and (c) is relatively the same in each individual at particular stages in life. Contrasted with a reflex, an instinct (a) may be elicited by a variety of stimuli instead of one; (b) involves connections in the midbrain, medulla, and cerebellum, instead of the spinal cord, and (c) involves the movement of a number of muscles, instead of one or a few. An instinct may be described further as an inherited *combination* of reflexes which unfold in a given pattern that characterizes a particular species. Such reactions as this definition implies comprise a relatively large number of specific functions. (3)

Types Appearing in Infants

The following types of activities are found in all infants at or soon after birth: (a) gross bodily movements, such as wriggling and squirming, and the somewhat aimless movements of the head, limbs, and trunk; (b) vocalizations, such as crying and screaming; (c) defensive or protective reactions, such as pushing, pulling, and striking with the hands and feet; and (d) expressions of emotions, such as smiling when pleased, jumping and crying when frightened, and fighting and screaming when angered.

Any one of these patterns, it may be pointed out, is present in each individual, is aroused by more than one stimulus, and involves a number of specific movements of different muscles. Crying, for example, may be produced by internal stimuli, such as hunger, thirst, and pain, and by such external stimuli as loud noises, bodily discomfort, and pain inflicted on the skin. In other words, such reactions as crying could hardly be classified as reflexes; thus, the term "instinct." (17)

Appearance of Delayed Instincts

Not all instincts are present at birth; many appear as a result of structural growth. These latter include such well-defined

patterns as (a) feeding activities, (b) vocalizations, (c) locomotion, and (d) general bodily activity. Not all specific reactions that could be listed under these headings are inherited, of course, but here are certain ones which seem to be the products of intrinsic factors.

FEEDING ACTIVITIES. These include the mastication and digestion of food. Food is at first taken into the mouth by sucking movements, but upon the appearance of the teeth, mastication begins. By this time the salivary and other digestive secretions are sufficiently strong to dissolve plant and animal food stuffs, and the individual changes his mode of eating.

VOCALIZATION. On account of the ease with which vocal sounds are modified by children, it is impossible to determine which of the many appearing at various stages are inherited. During the first thirty days of life, an infant has been observed to make nearly all of the fundamental vowel sounds and no less than ten or twelve consonant sounds. By the end of the fourth month, the average infant can make a sufficient number of sounds to utter almost any word. Real speech does not begin, however, until the beginning of the second year. Language sounds are not inherited. The child has to learn particular word patterns by imitating the sounds of the speech that goes on around him. Nevertheless, in most children language development is closely correlated with general physical and mental development.

MANIPULATION. The grasping, pushing, pulling, and striking movements observed in infants soon take the form of definite manipulative activities. These include the picking up, throwing down, picking at, squeezing, and pulling apart, of various objects within the reach of the child. These activities are thought to be inherited, because they are characteristic of every child, and because they appear in connection with the development of the use of the thumb. Infants, in grasping or holding objects, do not make use of the thumb, but only of the four fingers. As soon, however, as they are able to oppose the fingers with the thumb, they begin the acts of manipulation. Like vocalization, manipulation does not mature according to any particular pattern, except that it is limited by the arrangement of the fingers and thumb, and possibly by the organization

of nerve connections. *What* the child manipulates depends upon the nature of the object, its size, weight, and shape; whether it is satisfying or annoying; the previous experience of the child; and the opportunities provided by its social environment. It may be seen then, that manipulation, as far as it is an inherited function, is limited to the nature of the structures involved. The part that maturation performs in the function is important in that it is impossible for a young child to execute fine movements which involve a high degree of muscular co-ordination. All skillful performances, regardless of their natures, or the amount of training given the learner, must wait upon structural growth and development. During early life children can engage in motor activities which involve mainly the large muscles, because these are the first to develop. Later, however, they engage in those activities which involve the use of the finer and smaller muscles. Development of manipulative functions proceeds, then, from the coarser types of activities to the special and finer types which require the use of the smaller muscles. Thus, most human activities seem to have an inherited structural basis which limits accomplishment at any particular age, and an environmental basis which determines the particular patterns into which they fall.

LOCOMOTION. This term may be understood to include such activities as balancing the head, sitting alone, crawling, standing, walking, and climbing. Each of these motor activities develops in successive order during the first and second years of life. The average age at which normal children walk is 13.3 months. Running, jumping, and other forms of rapid movement are slower in developing, continuing to improve until the maturity of the muscles and bones is reached. This is not completed until the age of youth, and possibly in many instances not until maturity.

Evidence of the inheritance of these forms of locomotion is found in their universal character. They appear without failure in the normal child in any type of environment. There is further evidence in the similarity of the patterns in which these activities appear among members of the same family group. The son, for example, may assume a general posture, gait, or other pattern of performance, similar to that of his father; or children of the same family may exhibit strikingly similar

patterns of locomotion. Moreover, such activities appear to depend upon nerve centers in the medulla and cerebellum whose functions are largely automatic. More impressive still, there are a number of experiments on record which show that particular forms of locomotion, except crawling, perhaps, will appear and improve apart from the influence of training or practice. One such experiment described by Gates will be reviewed below.

Identical twins, T and H, were selected as subjects, because identical twins are known to have the same heredity. These children were presented with the task of climbing stairs of four steps which led to an object that would attract them. The experiment was begun when the twins were 46 weeks old. Twin T was given a six-week practice period in stair climbing. Twin H was given no training, and every precaution was taken to prevent him from getting any exercise similar to climbing. At the end of six weeks Twin T could climb the stairs in 25 seconds, and had made considerable improvement in his method of climbing. At this time Twin H was given practice in climbing the same stairs. His first trial was a successful ascent in 45 seconds less time than was required by Twin T's first trial. At the end of two weeks of practice Twin H could climb the stairs in 10 seconds, and his performance was considered superior to that of Twin T at the end of six weeks of practice. Thus, it may be seen that Twin H gained more efficiency with two weeks maturation than Twin T gained by four weeks of practice.

While the specific act of climbing may not be inherited, this experiment seems to indicate that the use of the trunk and limbs, which depend upon the co-ordination of specific motor responses, is a function of inner development. With regard to walking, it would be safe to assume an inherited pattern, and, it is generally accepted that a child would walk without any training or special practice. The training and practice that the child receives during the initial stages of the development of the functions serve only to hasten the co-ordination, growth, and development of the bodily organs.

The day upon which the child first walks is one of the most significant in his life. It is this phase of motor development that enables him gradually to extend his environment, and eventually to become independent of others. His upright pos-

ture, and his ability to move himself about from place to place likewise provide an opportunity for the exercise of numerous other inherited capacities, as well as for the acquisition of many new forms of behavior. (7, 9)

MENTAL ACTIVITIES

Meaning and Classification

General Description

By "mental activities" is meant the conscious states and processes previously described as subjective forms of behavior. These include those functions that do not involve muscular or glandular behavior, except the specific acts involved in the adjustment of the sense organs. The only way we can observe and study such activities directly is by introspection; but we can infer their existence, even in infants, by observing various objective activities in the light of our own experiences.

Types of Mental Activities

Mental activities are usually divided into three classes: (a) mental elements, including sensations and affections or feelings; (b) affective states, including complex feelings, emotions, and tendencies; and (c) thought processes, including perception, association, memory, imagination, conception, and reason. By *mental elements* is meant the simplest forms of consciousness to which all other forms can be reduced, or in terms of which other forms can be analyzed. By affective states is meant various degrees of pleasantness or unpleasantness or of satisfaction or annoyance. By *thought processes* is meant the various ways in which ideas, thoughts, and meanings arise and go on in consciousness. (18)

Inheritance of Mental Activities

Mental Activities of Infants

The only way we can determine which of the mental functions just described are inherited is to determine, if possible, the nature of mental activity in infants. In order to do this we have to observe their motor activities and from these infer the existence of mental functions; for the infant cannot introspect

nor give a verbal report of what he consciously experiences. William James must have done this when he concluded that "a baby, assailed by eyes, ears, nose, skin, and entrails, feels it (all) as one great, blooming, buzzing confusion." This means, apparently, that the infant is capable of experiencing sensations, feelings, emotions, and tendencies, and of giving attention, but it is incapable of engaging in any of the thought processes. That is, the infant's behavior reveals that it sees, hears, tastes, smells, etc.; that it experiences pain, pleasure, displeasure, fright, anger, etc.; and that it gets hungry, thirsty, fatigued, etc.; but that there is little evidence of perception, memory, imagination, or reason. The terms used here to refer to distinguishable mental acts in infants, and thus to describe inherited functions, need defining and illustrating. (8)

Sensations

Description

The term *sensation* is used to describe the simplest of all conscious experiences or responses. It appears to be the immediate conscious effect produced by the discharge of nerve impulses into a particular sensory area of the cerebral cortex following the stimulation of a given receptor. It consists of being aware of a given quality of the stimulus. For example, when the receptors of the retina are stimulated by light rays, nerve impulses are initiated and discharged over the neurons of the optic nerve to the visual area of the occipital lobe. When the impulses reach this area, the individual sees the stimulus and becomes aware of its color and form or of its qualities. This type of awareness, that is, of the particular qualities of a stimulus, is what is meant by sensation. (18)

The Neural Arc

All that is needed for a sensation to occur, it seems, is a stimulus, a receptor, a sensory neuron, and a definite sensory area in the cortex. This group of organs constitutes the "sensory neural arc," which appears to be even simpler than the reflex arc described previously. For this and other reasons, many psychologists regard sensations as the simplest forms of behavior, and consequently as the units to which all other

forms can and should be reduced. Thus, instead of explaining behavior in terms of reflexes, many psychologists explain it, particularly mental processes, in terms of sensations. This is why sensations are classified above as mental elements.

Types of Sensations

Sensations, being of many different varieties, are usually classified in terms of the different types of receptors. We may have the following types: (a) visual, which include all colors and forms; (b) auditory, all different tones and noises; (c) olfactory, all odors; (d) gustatory, the various taste qualities; (e) tactual, all touch, pressure, pain, cold, and warmth qualities; (f) static, all balance qualities and dizziness; (g) kinaesthetic, awareness of particular movements, strains, etc.; and (h) organic, all specific experiences due to the stimulation of internal receptors. While we classify sensations into these groups, it must be remembered that a single sensation is the awareness of any particular quality.

Appearance and Maturation of Sensory Qualities

It is generally believed that the individual is capable of experiencing all sensory qualities or sensations at and soon after birth. At birth, for instance, when the child breathes for the first time, there is the possibility of sensations of coolness from the air, and of pain from movements arising from the respiratory tract. The infant also has the possibility of sensing the movements and conditions of the internal organs. There are the possibilities also of various cutaneous or tactual sensations, such as coolness, warmth, pressure, touch, and pain, resulting from numerous contact stimuli. Soon after birth, light stimuli seem to affect the retina, and in a short time, the infant begins to notice colors. As soon as the middle ear is cleared of mucus, the child begins to show awareness of particular sounds. We may infer, further, that the young child is capable of being aware of various tastes and odors. Thus, in the main, the young child is capable of getting all of the different types of sensations. Furthermore, as the child reacts in these simple ways to the numerous stimuli that impinge upon the sensory equipment, he is getting the fundamental experiences that form the basis of complex mental functions which appear later. (5)

Feelings

Description

The term *feeling* describes the states of pleasantness or unpleasantness which appear to accompany many sensations. When one tastes quinine, for example, the most primary response is the *sensation* of bitterness; but accompanying this sensation, is the *feeling* of unpleasantness. Similarly, when one drinks coffee, one senses the gustatory and olfactory qualities; and one likes the coffee, or experiences pleasantness when drinking it. Feelings, or affections as they are sometimes called, appear to be mental states which accompany many sensations, but they are frequently regarded as attributes of sensations rather than separate qualities. As previously noted, feelings seem to be due to the discharge of nervous energy into the thalamus. If this is the case, they are separate conscious events, and should be considered as elements of consciousness along with sensations. (18)

Evidence of Feelings in Children

Feelings or affections are manifested in children by the so-called *positive* and *negative* responses. *Positive* responses are motor activities toward a particular stimulus, to obtain, to hold, to get more of, or to possess it. *Negative* responses are the reverse; that is, to get away from, to avoid, or to escape a particular stimulus. Such responses appear in infants in many particular instances. Why do they occur? The only answer we know to this question is that the stimulus that elicits a positive response also occasions a mental response of pleasantness or satisfaction; and this latter response then serves as a stimulus for the recurrence of the former. A negative response to a given stimulus is due, of course, to the unpleasantness or annoyance aroused by the stimulus that elicits it. Many such feeling states arise from internal activities and conditions.

Emotions

Description

Emotional reactions include such functions as love, rage, and fear. These are among the most complex inherited functions.

A complete emotional reaction involves both mental and motor activities; and the motor activities, in turn, are both somatic and visceral. Observe, for instance, what occurs when one is frightened. *First*, there is a confused mental or psychic state consisting of a group of sensations and feelings occasioned by the stimulus. *Second*, there is a somatic reaction consisting of various particular responses, such as the sudden catching of the breath, clutching with the hands, waving with the arms, crying or screaming, and various facial expressions. This is essentially a complex pattern of reflexes described previously as an instinct. *Third*, there are various internal or visceral activities. The heart beats violently, breathing is hurried and labored, digestion stops, and various other changes occur. *Fourth*, following all of these reactions, the individual usually exhibits a strong tendency or desire to flee or escape from the object occasioning the fright. Summarizing the entire pattern, we have a sudden, unexpected stimulus impinging upon an external receptor. The confused psychic or mental state that follows is called an *emotion*. The somatic and visceral disturbance is an instinct usually designated as the "expression" of the emotion. The desire to flee from the stimulus is an *emotional tendency* or *drive*. The entire process is an *emotional reaction*. Later, an effort will be made to describe several such reactions and to suggest how they arise. (18)

Emotional Reactions in Infants

According to studies made by John B. Watson, there are three fundamental types of emotions: fear, rage, and love. Fear may be produced in infants by making a loud noise or by suddenly removing the infant's support, thereby producing the sensations of falling. When such stimuli are presented, the infant will exhibit many of the somatic and visceral responses suggested above. Rage or anger can be aroused almost from the moment of birth by holding the infant in such a manner as to hamper or interfere with its movements. When the stimulus is applied, the infant begins to twist, squirm, pull, push, scream, turn red in the face, and to exhibit a tendency to attack or fight the offending object. In reality, he clearly exhibits rage or anger. Love or intense pleasure is manifested in infants in the positive responses made to certain types of stimulation.

It is usually expressed in such activities as lying quietly, smiling, gurgling, cooing, ceasing to cry, and in movements indicating a desire to prolong a stimulus. The stimuli for such responses include stroking, tickling, or touching certain "sensitive zones," as the cheeks, ribs, and sex organs, or by massive contact stimulation furnished by petting, caressing, and rocking. When well and "feeling good," the infant manifests various pleasurable states akin to love or strong affection. At first, these states are not attached to any particular person or object but occur only when the sensitive zones receive relatively intense stimulation from any source. Later, they become attached to persons and objects for which the infant shows marked preference.

During infancy, if not at birth, the individual exhibits the additional states of sorrow and grief. These states are usually occasioned by physical injury or discomfort or by hunger and thirst, or any condition brought about by helplessness. Just how far the infant experiences real sorrow or grief is unknown, but there is evidence of such emotions in certain types of crying and in the shedding of tears. Expressions of sorrow and grief appear, therefore, to have an inherited origin. (17)

Other than fear, rage, love, and grief, or elements of these, the infant exhibits very few, if any, emotional reactions. Later in life, of course, many others appear as a result either of structural growth or of learning or of both.

Types of Emotional Reactions

Like sensations, emotional reactions may be classified in a variety of ways. Some classifications emphasize the conscious processes; others emphasize the physiological processes. Following are the types most frequently recognized: (a) *Carnal,* including fear, anger, lust, rage, malice, envy, and hatred; and *spiritual,* including pity, sympathy, kindness, joy, and reverence. This classification is one usually employed in religious discussions. (b) *Passive,* such as shame, embarrassment, timidity, sadness, and grief; and *active,* including love, joy, rage, hatred, fear, etc. This classification emphasizes the presence or absence of somatic behavior in emotional reactions. Passive emotions involve a minimum of such behavior, while active emotions involve a considerable amount. (c) *Strong,* such as

fear, rage, grief, horror, and ecstasy; and *weak*, such as pleasure, affection, kindness, and mild happiness. This classification divides separate emotions according to their strength or violence. It suggests that some are mild, almost imperceptible states, while others are extremely strong and violent. (d) *Primary*, such as fear, rage, and love; and *derived*, such as pity, sympathy, gratitude, jealousy, patriotism, and zeal. Primary emotions are usually considered inherited, while derived emotions are combinations of elements of the primary states and are acquired. (e) *Pleasant*, such as joy, ecstasy, gladness, passion, and love; *unpleasant*, such as fear, horror, rage, and hatred; and *mixed*, such as pleasure and fear, anger and love, horror and rage, and "thrills." This is probably the most commonly used classification, as it emphasizes states that are more or less opposite in character. (f) *Cranial*, including mild pleasurable states, gladness, lively interest, and zeal; *sacral*, including passion and lust; and *sympathetic*, including fear, rage, anger, horror, and others. Here emotions are classified according to the division of the autonomic nervous system involved in arousing the visceral processes associated with them. For our purpose this is probably the most useful of the classifications proposed. It is one that we shall stress in a later discussion of emotions. (7, 10, 13)

Tendencies

Description

Many of the reflexes and instincts described above, particularly the visceral processes, give rise to certain conscious states variously designated as *tendencies*, *urges*, *drives*, *cravings*, and *motives*. Each of these terms is used to describe such states as hunger, thirst, sleepiness, fatigue, and sex desire, that prompt the individual to act in various ways. These states, and others to be mentioned later, seem to arise when various bodily processes reach a certain degree of intensity. For instance, hunger is due to the irritation which results from the rubbing together of the walls of the stomach, thirst to excessive dryness of the throat, fatigue to poisons in the tissues produced by muscular strains, and sex desire to the arousal of the sex organs. Preceding these states, there is usually some organic stimulus,

frequently designated as a "tissue need" that stimulates the bodily organs suggested to rather intense activity. When this occurs, the individual becomes conscious of a tendency that prompts him to make vigorous efforts to satisfy it. Because of their prompting driving character, tendencies are frequently described as the main-springs of human action. They are, at least, the bases of a vast number of wants and desires that account for a large portion of human action and endeavor.

In this chapter, we shall do little more than present various classes of tendencies and indicate those that are inherited. In later chapters, we shall describe how these tendencies arise and operate and show how they influence behavior in general.

Classifications

There are many ways in which tendencies may be classified, and each classification emphasizes their nature and importance as inherited traits. For this reason, several classifications will be passed in review.

One way of classifying tendencies is according to their utility. From this point of view, there are three classes: (a) those which preserve the individual, including self-preservation, urge to breathe, to eat when hungry, to drink when thirsty, to sleep, to rest when fatigued, to get warm when too cool, to get cool when too warm, to fight when angered, to flee when frightened, to approach an object of devotion, and perhaps many others; (b) those concerned with the perpetuation of the race, including the general tendencies to mate, to reproduce, and to care for the young, and a host of specific tendencies related to each of these, such as the impulses associated with mating and reproduction and the tendencies to love and protect the offspring; (c) those concerned with the perpetuation of the tribe or social unit, including the tendencies to congregate, to compete or rival, to master or dominate other persons, to submit to a superior person, to secure social approval, to avoid social disapproval, and perhaps various others.

This classification emphasizes the directions in which tendencies should be expressed in order to be of the greatest value. We can see, at least, that human society is organized as it is mainly because such organization enables individuals to find

expression for their fundamental urges or drives. If this were not so, it would be very difficult, if not impossible, to perpetuate the social groups suggested. Nevertheless, this classification does not emphasize the basic character of particular urges or suggest how they arise and operate in the individual to prompt him to act in the directions indicated. Furthermore, the classification doubtless suggests many tendencies that are not inherited. Later, we shall try to show that most of those in the second and third classes are probably acquired.

A second classification is based on the point of view that regards tendencies as specific responses to different types of stimulation. This classification also includes three types: (a) responses to organic stimuli, such as food getting, drinking, sex activities, and crying; (b) responses to objects in the environment, such as sensory functions, vocalizations, manipulation, and physical exploration; and (c) responses to other persons, such as mastery, rivalry, and fighting. This classification is useful in that it emphasizes different types of stimuli to which individuals adjust in various ways, but it reveals a number of weaknesses. First, it emphasizes the expression of a tendency rather than tendencies themselves. "Food getting," for example, is not a tendency, but is an activity growing out of the hunger urge; similarly, rivalry is not a tendency but a type of activity resulting from one. Second, the terms used to designate tendencies in this classification indicate nothing in particular that a person does. The term "food getting," for example, may include either the sucking or swallowing movements in infants or a highly socialized type of work such as school teaching or operating a business. In short, "food getting," "vocalization," "rivalry," and other similar terms are only class names each of which signifies not a given urge or drive but a number of different activities.

A third classification includes four types of tendencies: (a) physiological, (b) emotional, (c) social, and (d) mental. *Physiological* tendencies include hunger, thirst, urge to rest, sex impulses, urge to be bodily active, etc. They are thus designated because they arise from fairly definite physiological functions or conditions. Hunger, for instance, arises from irritation produced by contractions of the stomach walls, and sex impulses from disturbance in the sex organs. The same general principle

is true of other tendencies. *Emotional* tendencies arise in connection with feelings and emotions, usually following muscular and mental conditions associated with these responses. These include the tendencies to flee when frightened, to fight when angered, to collapse when grieved, and to approach an object of devotion or love. *Social* tendencies include those listed above in the third group under the first classification. As suggested above, these are probably combinations of physiological tendencies, which arise as a result of the individual's effort to satisfy the latter in his social environment. *Mental tendencies* include curiosity, the tendency to learn, the urge to solve problems, and the like. These tendencies, like those designated as social, are also probably based on the physiological and emotional tendencies. (1, 13)

Development of Tendencies

Any effort that may be made to show the age at which particular tendencies appear and the sequence in which they appear is nearly always fruitless. The reasons for this are perhaps apparent: *First,* most inherited tendencies appear during the earliest stages in life, probably during babyhood and early childhood, and at this time it is very difficult, if not impossible, to discover particular ones. If the observer seeks to discover particular tendencies by questioning young children, he cannot rely on their answers, for children are unable to tell why they do things. Or, if the observer tries to infer the existence of tendencies by observing different forms of behavior, he can easily infer the wrong tendency. In fact, any particular form of behavior may be the outcome or expression of a number of tendencies. *Second,* it is difficult to distinguish between inherited and acquired tendencies, either by introspection or by observation of behavior. For these reasons, no effort will be made to show the stages at which particular tendencies appear. Later, however, an effort will be made to show how particular tendencies are expressed at different stages in life. Regarding the development of tendencies, suffice it to say here that they doubtless appear in definite form in connection with structural growth and development. That is, whatever inherited tendencies the human being does not possess at birth appear in connection with the growth and development of structures.

Attention

Description

Attention may be defined as the focalization of consciousness upon a given stimulus and the consequent disregard of other stimuli. Suppose, for example, that a bright light comes within the range of vision, and its rays strike the retina from the side. The individual will respond somewhat as follows: There is, first, a rotation of the eyeballs and often a turning of the head toward the source of stimulation. This is followed by an accommodation of the eyes, which puts the retinal image on the fovea in the position of clearest and most distinct vision. At the beginning of this activity, the individual is aware only of vague sensations, but with the image on the fovea, he becomes highly aware of its color, form, and other qualities, and possibly of its meaning and significance for him. The meaning and significance attached to the object are, of course, the products of previous experience; but the attentive act seems to be an inherited function. If there is something about the stimulus that is pleasant or meaningful to the individual, attention will probably be sustained for a period of time, during which the object seems to take precedence over all others and to dominate consciousness. That is, the individual is usually unaware of all other objects and events, except in the most hazy and indefinite manner, unless others are related to the stimulus at hand. This total act is an example of what is meant by attention.

Such an act usually takes place even in infancy, and appears to be an inherited pattern. Thus it seems that human beings are so organized, structurally, that any sense stimulus of sufficient intensity may take precedence over other stimuli. What occurs seems to be as follows: (a) a nerve impulse is initiated at the sense organ; (b) the nerve impulse is discharged into the cerebral cortex, where it displaces or dominates any other nervous activity going on; (c) the organism becomes aware of the stimulus qualities or their meaning, and this conscious act is dominant over others; (d) the total act of consciousness is sustained as long as it is pleasing, or meaningful, or not displaced by another act aroused by a more potent stimulus. (2)

Types of Attention

Inherited and acquired forms of attention are frequently classified as (a) free, passive, or involuntary, and (b) forced, active, or voluntary, respectively. The first type is a spontaneous act in which the stimulus or situation inherently claims the focus or center of consciousness, without any feelings of effort on the part of the organism to select this particular stimulus. The stimulating object, as it were, seems to seize upon consciousness and to control it, without the individual's being able at first to ignore it. The stimulus simply breaks in upon consciousness and dominates the mental processes until the individual is stimulated to attend another object of greater stimulus value.

Forced, active, or *voluntary* attention, on the other hand, is a state of consciousness sustained toward a particular stimulus that does not inherently attract the organism. During this state, the individual is aware also of an effort to select this particular stimulus from among others more inherently potent. This type of attention depends upon factors other than those belonging to the stimulus, such as a sense of value, some purpose, or an ultimate goal. Consequently, it is usually the product of definite training. At any rate, as development goes on, individuals acquire the ability to ignore the crass or insistent objects which claim passive attention and learn to concentrate upon those which have greater significance in the light of past experiences. One may ignore the noises of the street or the presence of other persons, for example, for the sake of concentrating upon the task at hand. The feelings of effort or strain that accompany this type of attention suggest the terms "forced," "active," and "voluntary" or willed attention. Since this type of attention is a product of experience and training, further discussion of it need not be presented at this time. Suffice it to say that the acquired ability to hold the mind to that which, at present, exists only as an aim to be reached, or an ideal to be realized, is one of the most important of all human acquisitions. (2, 5)

Qualities That Attract Attention

What the individual instinctively attends does not depend upon any particular type of object or event, but upon the

qualities of the stimulus and the way they affect him. That is, any stimulus will attract attention if it is intense enough to arouse vivid sensations, if it is a moving or rhythmical vivid sensation, if it arouses pleasantness or unpleasantness, or if it is an internal condition of some degree of intensity. Such stimuli are said to possess the qualities of intensity or vividness, contrast, striking quality, and movement or repetition. Bright lights or objects, noisy objects, unusual events of any kind, including such internal conditions as hunger, thirst, pain, and indigestion, possess these qualities, and they seem to have a sort of natural attractiveness for the human being which prompts him to select them from among other stimuli.

The reason why we naturally attend to objects that possess these qualities is not known for certain, but it appears that they are more potent, in the way they affect nerve tissues, than are other qualities. For example, a bright light or a loud noise is more effective than a weak light or noise, a moving object more potent than a static one, and so on, for the reason that nerve tissue is more sensitive to the one quality than the other or to strong than to weak stimuli. This, in fact, is its nature. Steel will stand a harder blow than will glass, because it has, by nature, more tensile strength. In order to explain attention, at least, we do not have to resort to the theory that attentive adjustments are racial habits transmitted through the germ plasm, as many theorists have done. Attentive acts, as we are trying to show, are due to the nature of the structures themselves; that is, to their capacities or tendencies to respond to strong and weak stimuli in different ways just as inanimate objects may do.

Importance of Attention

As structures develop and grow, attentive acts become extremely important as *preparatory responses* for acquired motor and mental reactions. Motor activity of the instinctive variety does not require attentive adjustment as a preparation for its performance, but motor activity of a complex, acquired type is initiated and continued by a high degree of attention. In fact, the first step in the process of acquiring motor activity, and in all mental activity, is always attention. Thus, attention seems to put in its appearance when it is required as an aid to

further behavior. When it is not much needed, as in the case of instinctive or habitual behavior that is mechanical in its operation, attention is free to shift from one thing to another, according to the type of stimuli available, or according to the desires and inclinations of the performer. When it is needed, it directs activity toward the accomplishment of the ends or purposes of the performer. (2, 14)

CAPACITIES

Description and Types

Description

Another group of traits that appears to be inherited is known as *capacities.* These are distinguished from functions in that they are general and specific abilities or powers that psychologists attempt to measure. That is, a capacity is a particular mental or motor function possessed by an individual in a given amount or to a certain extent. A capacity may be considered also as the ability of an organ or of the organism to do work.

Types of Capacities

If classified in terms of abilities of particular organs, capacities are divided into the following types: (a) of the sense organs, such as eyes, ears, and touch corpuscles; (b) of the nervous system, such as of the brain, neurons, etc.; and (c) of the reactors, such as those of various muscles and glands. Since it is difficult to conceive of the capacity of an organ apart from the nature of the function it performs, capacities are usually classified in terms of various functions. When they are classified on this basis, capacities are of the following types: (a) sensory, (b) motor, and (c) mental. This classification will be followed in our discussion below.

Inheritance of Capacities

We may also classify capacities as inherited and acquired, and then sub-divide them as indicated above. An inherited capacity is one that an individual receives through the genes from his parents and other ancestry; while an acquired capacity is one that exists as a product of experience or training. In order

to determine whether a particular capacity is inherited, it is necessary to show: (a) that it exists in a constant amount in the same individuals from year to year; or, (b) that any changes that occur are due to structural growth and development; or (c) that it cannot be changed by practice or training. If a capacity is increased by practice or training, in any appreciable amount, or if it decreases or fluctuates from time to time, it is acquired.

Sensory Capacities

Types Included

Sensory capacities include: (a) the sensitivities of the sense organs, and (b) discriminative capacities. The first group includes the capacities to see, to hear, to taste, to smell, to experience pain, and the like. The second group includes the capacities to distinguish between color, shades of color, light and dark shades, between tones of different pitches, between tactual stimuli, etc.

Sensitivities

Measures of sensitivities include various tests of seeing, hearing, tactual sensitivity, and the like. Because of their practical usefulness in the school room, greatest attention has been given to the capacities for seeing and hearing. Measures of these capacities indicate two important facts: (a) ability to see and to hear reaches maturity during the first four years of life; (b) individuals vary considerably in their abilities; and (c) nothing can be done to improve or increase these capacities, or any others in this group, except to correct particular defects. Moreover, the testing techniques are so completely refined that they can be employed successfully only by experts. The prevalence of sensory defects among school children is greater than is commonly supposed, as various studies have shown. Thus teachers should be on the alert to discover signs of them and to report them to parents and experts. The exact nature of these defects will be described in a later chapter. (7)

Discriminative Capacities

These capacities are measured by a large variety of tests, such as naming and matching colors, matching forms, telling

which is the higher or lower of notes sounded in immediate succession, lifting weights, noting the distance between two points on the skin, and similarly for each of the different senses. Studies of such capacities have revealed a number of interesting facts. First, improvement of discriminative capacities is rarely ever attained by practice, except as a result of better attention, increased understanding of directions, better ability to compare, etc. Thus these seem to be inherited abilities. In skin sensitivity and discrimination, tests show that children are more sensitive than adults, and that practice may improve these capacities to a very limited extent. Nevertheless, the amount of improvement resulting from practice of any particular function is insufficient to justify formal drill or "sense training" in school. Second, individuals of the same age vary in these capacities. There are those who possess very little ability in any given function and those who possess a greater amount. The great majority of individual measures, however, cluster about the average, varying on either side in about the same manner. The first suggests, further, that heredity determines many of the differences between individuals. (7)

Motor Capacities

Specific

Motor capacities include various specific capacities and general motor ability. The specific capacities are measured by devices which determine the strength, speed of contraction, and endurance of any muscle or group of muscles. An index to muscular strength is a measure of grip by means of a dynamometer, which registers the number of pounds pressure a person can exert with the grip of either hand. Speed of contraction is usually measured by recording the number of times a person can tap in a period of thirty seconds or more. Endurance is measured by noting the number of times a weight can be lifted by one finger a given height in a specified amount of time. Results of such tests show that boys usually surpass girls and that older children usually surpass the younger ones. The amount of improvement is gradual from birth to maturity. Improvement with practice will occur at any given age, but the amount is usually slight. The individual reaches a level that he cannot

surpass until he undergoes further growth and development. Individuals of any given age vary considerably in these capacities. (7)

General Motor Ability

This capacity is measured by putting individuals through a number of exercises requiring varying degrees of muscular co-ordination of both large and small muscles. A motor test for young children, to measure co-ordination of the large muscles, includes such activities as jumping, balancing, stepping over hurdles; and a test to measure co-ordination of the small muscles includes such items as cutting with scissors, fitting forms, sewing, and winding. A test of motor ability of older children and adults includes such activities as walking ten steps in a straight line, kicking as high as the head with one foot, jumping up and striking the heels together in the air once or twice, jumping up and turning around in the air, and sitting cross-legged and getting up. Studies made by both types of tests reveal wide differences between individuals and sexes, and suggest that general motor ability is inherited. At least, practice in performing particular acts, at a given age, fails to result in any great gains. (See Chapter XVII.)

Mental Capacities

The term "mental capacity" is a very inclusive term which might be taken to cover all of the specific abilities described above as sensory and discriminative capacities, as well as the capacities to perceive, memorize, reason, judge, and to perform various other complex functions. Since we have already designated the former group under a different heading, and since the latter group depends largely upon acquired elements, we shall restrict the term here to two general capacities: (a) intelligence and (b) capacity to learn.

Intelligence

The term "intelligence" is used to designate the general capacity to deal with new or novel situations involving abstract elements. It is tested by confronting the individual with a series of questions, exercises, problems, or other items and noting the number of items answered or solved correctly, usually

in a given length of time. Before it is used as a measure of intelligence, the test comprising the various items is usually standardized. This is done by giving it to an adequate sampling of individuals of different ages. The items selected for a given test are always within the range of the ability of a normal individual of a definite age level. In the famous Binet test, for example, a child of three is asked to point to nose, eyes, and mouth; to enumerate objects in a picture; to give his family name; and to repeat a sentence of six syllables. A child of six is asked to distinguish between right and left; to count thirteen pennies; to name missing parts of mutilated pictures; and to tell whether it is morning or afternoon. If such a test is given to a child of six, he should be able to answer all of the questions in order to be classified as a normal child.

Suppose, however, that a child of six is able to answer, not only the questions intended for his age but also those intended for a child who is eight years old. In this instance, he would be mentally above normal, and his *mental age* would be eight instead of six. By dividing the mental age (M.A.) by the *chronological age* (C.A.), the *intelligence quotient* (I.Q.) is found. Thus the I.Q. of a six-year-old child who passes a test for a child eight years is 8/6 or 133. If a child of six, however, is able to pass only the items intended for four-year olds, his I.Q. is 4/6 or 66. (Decimal points are dropped in calculating the I.Q.) Moreover, if a child of six passes the test designed for six-year olds, his I.Q. is 6/6 or 100, which is the I.Q. of the normal child.

In order to describe individuals of different I.Q.'s, or degrees of intelligence, Terman has arranged the total population in the following types:

I.Q.	Classification
140 and above	Near genius or genius
120–140	Very superior
110–120	Superior
90–110	Normal or average
80–90	Dull
70–80	Moron, borderline
0–70	Feebleminded (imbecile and idiot)

Frequently the terms "bright," "medium," and "dull" are used to describe persons of superior, normal, and low intelligence, respectively. From this arrangement of persons on a

scale, it is clear that the I.Q. is used as an index of an individual's level of intelligence and that the primary object of an intelligence test is to rank the individual in this trait in comparison with others of his own age level.

One of the chief reasons for believing that intelligence is inherited is that the I.Q. remains relatively constant from year to year. A child whose I.Q. is 100 at age three will most probably reveal the same I.Q. at any successive age. There may be fluctuations up or down, but there is a strong likelihood that they will not be great in the case of any given year. This fact implies that a child who is bright at one age will be bright at a later age; that a feebleminded child has little chance, if any, of increasing his I.Q.

The constancy of the I.Q. must not be taken to mean that the amount of intelligence remains the same in a given individual from year to year. What remains constant is the I.Q. or *ratio* between his mental and chronological ages. As a matter of fact, intelligence, as well as other mental capacities, increases gradually with age until it reaches maturity at about sixteen or eighteen years. Investigators disagree as to the exact age at which it matures, but nearly all indicate that this age is reached during or immediately following adolescence. Thus the growth in intellectual capacity seems to keep pace with the growth of bodily structures, particularly with that of the brain. (7)

The Capacity to Learn

This may be described as the capacity to adapt to new and varied situations to which the organism is at first unable to react successfully. Like intelligence, the capacity to learn is a composite of numerous specific capacities which are called into play in definite situations. The two seem to be related in that an intelligent person usually learns faster and more quickly than an unintelligent one, but the two capacities are not identical. Whereas intelligence is measured by determining the number of problems or questions the individual can solve or answer without previous formal training, the capacity to learn is measured by noting the rate of progress made in attempting to react to a new situation, or to a group of new situations. The rate of progress is usually determined by observing the

number of trials, or amount of time, or both, required by the individual to organize a successful and relatively permanent mode of reaction. A person learns to solve a puzzle, for example, by making a series of trials, errors, successes, etc., eventually develops a pattern of action that will function each time he is confronted with the same or a similar puzzle. Likewise, one learns a poem or other group of items by reacting to the stimulating conditions again and again.

The capacity to learn a particular thing is not inherited, but it appears to have an inherited basis in the modifiability and retentiveness of nerve structure. Since these traits are native, the capacity to learn is partially native. Like intelligence, at least, the capacity to learn is present at birth in a certain amount which increases at a rate set by the rate of growth of maturing structures, until it reaches maturity some time during the thirties. Because of the deterioration that sets in among the structures, the capacity to learn begins to decline with old age. Perhaps the closest relationship between structural growth and capacity to learn is that indicated by the processes of myelination. At least the capacity seems to fluctuate with this process.

While the capacity to learn is substantially an inherited trait, it is one that is readily modified by experience and training. When the organism learns to adapt to one situation, for example, it is better equipped to react not only to that situation but also to all others similar to it. In like manner, familiarity with the facts and ideas in a given field enables the learner to master information faster in that field than in another less familiar. Thus the quickness with which an individual responds to a particular situation depends upon experience as well as upon native ability. (7)

The Bases of Mental Capacities

All mental capacities appear to depend upon three things: (a) complexity of the cerebral cortex, (b) its plasticity, and (c) speech. The cerebral cortex, as we have already observed, is the basis for the sensory and discriminative capacities. But the cortex is particularly adapted, not only to receive and retain impressions from the senses, but it is also capable of coordinating and integrating these impressions into systems of

meaning. This is because every part of the cortex is closely connected with every other part. This arrangement, at least, enables every incoming impression to link up with impressions previously registered. Thus modifiability and retentiveness and complexity of cerebral structures give man the ability to receive, retain, combine, and integrate impressions into systems of meanings which enable him to deal with new situations. By means of language, man is able to symbolize his concrete experiences so as to be able to deal with them in the abstract. Language also gives him the ability to communicate and co-operate with his fellows in changing his environment to suit his wants and needs. (15)

EXERCISES

1. Make an outline of the chapter and in it show the various types of inherited and specific traits. Illustrate each type.
2. Point out the similarities of and differences between *reflexes* and *sensations*. Show why reflexes are employed as explanatory units in behavioristic psychology, and why sensations are employed as explanatory units in mentalistic psychology.
3. Make diagrams showing the location of the nerve connections involved in visceral and somatic reflexes and instincts. In what ways do these forms of behavior differ?
4. Discuss the part played by structural maturation in the appearance, development, and maturation of functions and capacities.
5. List the activities that infants can do mentally, and show why they can do nothing else.
6. Describe *feelings* or *affections*. What evidences are there of these in infants?
7. Give meanings for the following terms: (1) feeling, (2) emotion, (3) emotional reaction, and (4) emotional tendency.
8. Make a list of tendencies and show what causes each tendency listed.
9. Which of the classifications of tendencies do you prefer? Why?
10. Why is it relatively impossible to distinguish between inherited and acquired tendencies?
11. Describe two types of attention, and show why individuals naturally attend to certain types of stimuli. Describe the stimuli to which one does not naturally attend.
12. Make clear the difference between *sensitivity* and *discrimination*. To what extent is it possible to improve each?
13. A mother said of her child: "A psychologist told me that my boy is feebleminded. Since he is only three years old, I am sure that he will outgrow his dullness after he starts to school." Was the mother correct? Why?

14. In what sense does one inherit the capacity to learn? How does this capacity differ from intelligence?
15. What is the physical basis of all mental capacities?

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CHAPTER VII

CHARACTERISTICS OF ORIGINAL TENDENCIES

INTRODUCTION

Purpose of the Chapter

In this chapter we shall study somewhat in detail the various types of tendencies classified and described in the previous chapter. Attention will be given (a) to their characteristics as mental states, (b) to the physiological processes that occasion them, and (c) to the inherited forms of behavior by which they are expressed. In a later chapter, there will be some discussion of acquired forms of behavior which result from various tendencies.

PHYSIOLOGICAL TENDENCIES

Attention will be given, first, to the nature and expressions of physiological tendencies.

Tendencies as Subjective Responses

How Tendencies Arise

The term tendency, as we have previously defined it, implies a subjective state, process, or activity that prompts the individual to act. Because they prompt, lead, or motivate the organism to act in a vigorous manner, tendencies are also called urges, cravings, motives, drives, and desires. The problem immediately confronting us now is that of showing how these states or processes arise. In order to do this, let us consider the following stimulus-response events:

S_1 *Bodily Condition*	$R_1(S_2)$ *Visceral Activity*	$R_2(S_3)$ *Conscious State*	R_3 *Somatic Responses*
1. "Empty cells"	Contraction of stomach walls	Sensation, feelings, "hunger"	Crying, eating, etc.
2. Cell poisons	Muscular tensions	"Fatigue"	Relaxing, resting, playing, etc.

The events diagrammed above seem to occur when we "feel" hungry or fatigued, these being selected as examples of physiological tendencies in general. Reading Example 1 across the page, S_1 is the initial stimulus preceding hunger. It is represented as "empty cells" or body cells depleted of their stored-up energy. This condition, usually described as a tissue need, leads to R_1, a visceral activity consisting of relatively intense stomach contractions. Though this is a response to S_1, it serves as a stimulus to the various receptors in the stomach walls, S_2, which initiate nerve impulses that give rise to the conscious state we call "hunger." In reality this state is a complex group of sensations and feelings, the conscious state designated as R_2. Because of the prompting or motivating character of this state it serves as a stimulus, S_3, to arouse the organism to action, R_3. This activity is somatic, overt, or objective, consisting of various forms of behavior, from the crying of infants to the eating activities or work of the adult.

Example No. 2 suggests how fatigue arises. This is an example of tendencies due to general or widespread bodily conditions rather than to definitely localized areas, as is the case in hunger. Fatigue, as suggested under S_1, is probably caused by the presence of certain poisons, chiefly lactic acid, which are found in the muscles and nerve centers after prolonged vigorous activity. The poisons appear as a result of chemical action which takes place in the individual cells when they are overworked. Fatigue, similarly to hunger, is experienced consciously as a group of sensations and feelings produced by strains and inhibitory effects of poisons in the muscles. The poisons acting as S_1 stimulate the muscles and they respond with these strains as R_1. The muscular strains, in turn, stimulate (S_2) the kinaesthetic receptors attached to the muscles and tendon fibers, and these initiate the nervous energy experienced as sensations and feelings of fatigue. Added to these states, there are doubtless other sensations and feelings due to stresses and strains among the internal organs, which have to speed up their functions in time of work to supply the tissues with food. The combined conscious result of all these processes is a very uncomfortable experience which prompts or drives one to cease activity or to seek rest. Man usually sits or lies down until the poisons are eliminated by the automatic action of the visceral processes.

We know that this conscious state is due in part to the effects of poisons, because a person who receives an injection of fluid from a fatigued muscle will "feel" fatigued without having done any vigorous work. (7)

Relation of Sensations and Feelings to Tendencies

The manner in which tendencies have been described indicates that they are complexes consisting of numerous sensations and feelings experienced simultaneously. The sensations appear to be due to cortical activity aroused by nerve impulses coming from the organic and kinaesthetic receptors in the bodily tissues. These are aroused, in turn, by the initial stimuli. The feelings experienced simultaneously with the sensations are either qualities of the sensations or are products of cortical activity also. Some think that feelings are not due to cortical activity, but to the activity of the thalamus or to midbrain structures. Be this as it may, there is always an affective or feeling state present in a given tendency, which gives it a pleasant or an unpleasant flavor or quality. In the tendency to be bodily active, for example, the affective quality is pleasantness or satisfyingness; while in hunger and thirst, it is definitely unpleasantness or annoyingness. It is these elements in a tendency which seem to give it the dynamic, driving power by which it is distinguished from mere sensation.

Both sensations and feelings originate, of course, in tissues that are aroused to vigorous activity. These activities also help to account for the dynamic quality associated with tendencies. A dog or a bird with the cerebrum removed, for example, will sit or lie perfectly quiet as long as the stomach is filled with food, or as long as its thirst is satisfied; but when the stomach is empty, or when the throat becomes dry, the animal or fowl will exhibit a restlessness similar to that of a normal animal or fowl. This implies that the tissues disturbed or aroused to action by a tissue need have some driving or motivating power to arouse overt activity apart from the conscious urge or drive experienced by man. Or it may mean that man merely becomes conscious of striving, driving, or craving tissues. In either instance, the sensations and feelings experienced are the significant aspects of tendencies from the standpoint of intelligent action. (9)

Somatic Behavior Associated with Tendencies

The somatic activities, indicated in the discussion above, refer to activities of the individual when a tendency is present and operating. These activities may be instinctive, or acquired, or both. When an infant is hungry, for example, it begins to wriggle and squirm, then to fret and whine, and eventually to cry in a vigorous manner. These are instinctive acts by which the infant tries to satisfy the tendency. It uses these because it can do little more. In later life, however, the individual takes very definite steps toward getting something to eat. The young child asks his mother or visits the ice box; and the older person follows his habitual patterns of behavior. This means that the activities growing out of any tendency vary in kind from instinct through habit to carefully planned behavior. Society, of course, has outlined somewhat definite ways in which individuals are trained to act when a given tendency is present.

Tendencies as Objective Responses

Criticisms

The view of tendencies outlined above may be contrasted with the view that they are not subjective but objective responses. Some psychologists, particularly the behaviorists, prefer to describe hunger, for example, as contractions of the stomach, or to describe fatigue as muscular strains. From this standpoint, every tendency consists of a chain of reflexes initiated by a tissue need. The reflexes unfold in a serial order producing the various types of behavior described above. We have no quarrel with this point of view, except that it fails to emphasize the qualitative or mental states that accompany the unfolding of the motor processes. It is these states that enable man to recognize what his needs are and to learn how to supply them. Thus, such words as "hunger," "thirst," and "fatigue" should designate the mental rather than the physical processes. In other words, the term "tendency" does not mean a muscular or glandular activity but rather a conscious state that occurs at or about the same time and as a result of the physiological response. This conscious state serves, then, as a dynamic stimulus to initiate and sustain general bodily activity, usually in the direction of satisfying the tendency. The physiological response

which gives rise to a tendency is what we have previously designated as an *instinct*. In this instance, the instincts are visceral rather than somatic acts. These, of course, are functions mainly of the autonomic nervous system by which internal or visceral reflexes and instincts are controlled. (7)

Supporting Facts

The view that tendencies are conscious states rather than objective responses is based on such experiments as the following: If a collapsed balloon is introduced into the upper end of the stomach and inflated at the time hunger is experienced, a record can be made of the contractions of the stomach. Other devices may be used to record contractions of the upper end of the intestine and esophagus. Observations made in this manner reveal that the stronger these contractions are the greater are the hunger pangs. Also, if all of the organs, or any of them, go into a spasm of contractions, the individual being observed feels an uncomfortable tension and becomes anxious to do something to get rid of it. Furthermore, if a balloon is inflated inside the stomach in such a way as to expand the stomach walls, the individual feels no hunger pangs. Thus, it appears that tendencies are subjective rather than physiological processes; the former, in fact, are effects of the latter. (10)

EMOTIONAL TENDENCIES

Emotional Reactions

The Total Process

An emotional reaction, as we have seen, is a psycho-physical disturbance. It follows an exciting stimulus that attracts a high degree of attention by coming upon the individual in some intense form. Emotional stimuli are usually objects or events that (a) are especially attractive; or (b) appear suddenly, unexpectedly, and strange; or (c) threaten or endanger the welfare of the individual; or (d) are too difficult for the individual to deal with satisfactorily. The organism reacts to such a stimulus in a relatively complicated and vigorous manner. The following diagram will help suggest the nature of the total reaction:

Psychical	R_1	Sensation Attention (Perception)	$S_2 .. R_2$	Disturbance Sensations Feelings	
S_1	R'_1	Visceral (Smooth muscles, glands)	$S'_2 .. R'_2$	Internal Sensations Feelings	R_3 Emotional Tendency
Physiological	R''_1	Somatic (Striped muscles, trunk, limbs, and face)	$S''_2 .. R''_2$	Kinaesthetic Sensations Feelings	

The Psychical Disturbance

The diagram means that an exciting stimulus, S_1, impinges upon an external receptor, arousing, first, a group of sensations. These sensations break in upon the mental life of the individual, suddenly or gradually, and disturb or interfere with whatever mental processes are taking place. The result is a high degree of attention to the exciting stimulus and a marked degree of mental disturbance of greater or lesser degree of intensity. This is indicated in the diagram as R_2, a complex of sensations and feelings. This disturbed state of mind is what we may call a "pure emotion." At the time the individual experiences this mental confusion, he likewise experiences a high degree of satisfaction or annoyance, and consequently a strong tendency or urge to react toward or away from the stimulus in a more or less vigorous fashion. The reaction that takes place is indicated as R_3. The tendency or urge present is what we have been calling the *emotional tendency.*

The Physiological Disturbance

While the psychical process is going on, there is also an accompanying physiological process. This consists of (a) a visceral disturbance, both of the vital organs and of the glands; and (b) a somatic response consisting of skeletal activities, which involve the muscles of the face, in particular, but frequently

those of the trunk and limbs also. These responses are of the nature of visceral and somatic reflexes and instincts. This combined visceral-somatic response, indicated as R_1' and R_1'', contributes to the physical state or pure emotion in a manner similar to that in which tendencies arise as mental states. That is, movements of the internal organs, S_2', stimulate the interoceptors, and in this way initiate nerve impulses that are discharged into the cerebral cortex; and the movements of the striped muscles and trunk stimulate, S_2'', the proprioceptors, particularly the kinaesthetic receptors attached to the muscle fibers, and initiate an additional group of nerve impulses that likewise reach the cerebral cortex. All of these impulses result in numerous sensations and feelings that fuse or combine with the emotion. This combined result, R_3, constitutes a strong mental condition designated by such terms as love, ecstasy, hate, anxiety, fear, rage, terror, and the tendencies associated with these. These states when prolonged, like physiological tendencies, drive, urge, motivate, or impel the individual to engage in endless varieties of behavior. These are *emotional tendencies.* (8, 14)

Theories of Emotions

The total psycho-physical reaction described above takes place with such suddenness, and affects the organism in such a variety of ways that various theories have arisen as explanations of it. Some of these merit presentation here.

James-Lange Theory

The James-Lange theory deals mainly with the sequence of events occurring in an emotional reaction. These investigators after much study arrived at the conclusion that an emotion is a mental state caused by a physiological response. James illustrates his theory by saying that we see an animal, perceive it as dangerous, try to escape, and finally experience fear. The "trying to escape" includes, of course, both visceral and somatic responses. James summarizes the theory in the following cryptic manner: "Bodily changes follow directly upon the perception of an exciting fact (stimulus) and our *feeling* of these same changes as they occur is the emotion." Since James means by "feeling" *sensing,* it is apparent from this statement that he

emphasizes emotions as conscious states, events, or processes following and due to physiological events, processes, or activities.

Recent investigations seem to show that James and Lange were essentially correct in the view that emotions are confused conscious states. Nevertheless, the idea that the emotion follows the physiological changes seems to contradict common sense as well as certain observations. Common sense avers that we see an animal, get frightened, and run; not that we run and experience fright. Besides, many emotions, such as fright occasioned by a loud noise, take place without any act of perceiving (recognition) having time to go before. Supporting this common sense view are various experiments with animals showing that emotions will occur apart from any physiological changes whatsoever. Such observations as the following are also significant: A woman suffered a fractured neck which resulted in complete paralysis of all her limbs; in the loss of ability to sense touch, pressure, and kinaesthetic stimuli, except in the head segment; and in the loss of the possibility of disturbing the internal organs by way of the sympathetic nervous system. Yet, this woman was capable of experiencing emotions; in fact, she showed no loss of emotional consciousness whatsoever.

Thus, it appears that physiological changes are not fundamental to emotions; and that they occur as accompaniments of emotional states and not as causes. There is no doubt, however, that visceral and somatic changes contribute a great mass of sensations and feelings to emotional states, and that these help to intensify, prolong, and color the emotion. (8)

Behavioristic Theory

As one might expect, behaviorists do not attempt to deal with the conscious states involved in emotional reactions. They identify an emotion with the visceral and somatic disturbances suggested above. The only difference between a tendency and an emotion, according to the behavioristic theory, is that the latter is more widespread and intense than the former. Both are chains of reflexes unfolding in serial order as a result of some tissue need or intense external stimulus. (14)

Our chief objections to this view were set forth in the previous discussion of the behavioristic view of tendencies.

Cannon's Theory

Cannon proposed the so-called Emergency Theory of emotions to account for the usefulness of the physiological changes that take place in emotional reactions. In this theory he tries to show that these are native provisions for helping individuals adjust to emergency situations. To support this view, he points out that the strong emotions, at least, occur when the individual is stimulated by sudden unexpected, or strange objects or events that usually demand corresponding types of activity. When confronted with such a stimulus or situation, the whole organism is thrown into more or less violent action which may be sustained by the actions of the glands until the emergency has passed, or until the organism has vanquished or escaped from the dangerous object. This theory is supported by observations of the characteristic behavior of an individual who is frightened, angered, or grieved. Cannon points out that this characteristic behavior may not be useful in the usual situations of modern life, but that it is of considerable value in the situations common to primitive man. Primitive man, because of his natural equipment of this type, would escape from a falling tree, attack a vicious beast, stand rooted to the ground unable to move in an impending disaster, or give himself over to loud lamentations. Thus, what human beings possess now in the way of emotional reactions are left-over patterns of reactions that were once useful in emergencies.

Cannon describes this characteristic behavior of man in a very effective way, and supports his descriptions with numerous facts. The main objection to the theory is that it fails to take account of such experiences as love, joy, gladness, glee, and others that cannot be classified as emergency reactions. The only way the theory deals with these is to disregard them as emotions and to classify them as something else. Since this is the case, the theory does not include a large group of experiences commonly regarded as emotions. (7, 12)

The Physiological Disturbance

The physiological disturbance suggested above, together with the mental disturbance, can be understood better by noting the changes that occur in different types of emotional reactions.

We may notice the (a) neural, (b) visceral, and (c) somatic changes that compose this disturbance and from these infer various mental aspects that have not been emphasized.

Neural Processes

From what has been said, it may be apparent that the psychical processes involved in emotional reactions are due to cortical and cerebral activity. These states which we may designate as "emotional consciousness" seem to arise as a result of the following neural activity: (a) An emotional stimulus acts on an external receptor and initiates a group of nerve impulses. (b) The nerve impulses are discharged into the thalamus (relay station for sensory impulses). (c) Here part of the nervous energy is distributed to the cortex and part to the visceral and somatic reactors. (d) That part of the nervous energy that goes to the cortex produces the first conscious state or "pure emotion"; and the part that goes to the visceral and somatic reactors produces the physiological disturbances. The nervous energy discharged to the visceral organs is conducted by one of the divisions of the autonomic system; and the energy discharged into the somatic reactors is conveyed by the motor nerves belonging to the cerebro-spinal system, and which come from the medulla and cerebellum. (e) The violent responses of the visceral and somatic reactors stimulate the internal and kinaesthetic receptors, respectively. The nervous energy from these receptors is conducted to the cortex by way of sensory nerves of the cerebro-spinal system. The final psychical state resulting from this additional nervous energy is an emotional tendency.

Thus, in the total reaction, there may be a widespread condition involving the entire nervous system as well as all of the reactors. The physiological responses seem to occur as instinctive acts aroused by an emotional stimulus and are not the causes of the emotion. The emotion is a conscious state that occurs at or near the same time the physiological responses occur. It is, therefore, a mental response to the emotional stimulus and not a mental response to the physiological changes. This is why it is possible for one to become emotional without a physiological response occurring, and why it is possible for one to reveal no emotion when a physiological disturbance occurs.

Both of these types of reaction have been observed in abnormal individuals. Nevertheless, the physiological changes have considerable effects upon the consciousness of the individual and upon his behavior resulting therefrom. Let us study some of these effects. (1, 7, 8, 12)

Visceral Processes

The visceral processes in emotional reactions, as we have observed, are produced by nervous discharges over one or the other of the divisions of the autonomic nervous system. We shall see how these changes are produced and shall note some of their effects on the organism.

Cranial Innervations. The stimuli that arouse the internal organs by means of the cranial division are those which produce pleasurable affective states, such as pleasure, gladness, joy, happiness, etc. The cranial innervations appear to heighten the activities of the internal organs only to a mild degree, though the disturbance itself is relatively widespread. The heart beats more slowly; the digestive system is toned up, causing an increase in the rhythmical movements of the stomach, and in the secretion of the salivary and pancreatic glands; breathing may increase in rate; the tear glands often moisten the eyes, as in joy; the entire viscera are toned up and made ready for a further reception of stimuli. This readiness is usually experienced consciously as a desire to be near the stimulus, and to keep or to continue it. If the stimulus is a living object, there is a tendency to caress or embrace it, or at least to be friendly toward it, to protect it from pain or distress, and to do for and give to it. These desires are components of affection, gladness, joy, pleasure, etc., derived from different things. Usually the changes effected through the cranial division are helpful and beneficial to the individual. They are particularly important for health and vigorous feelings of well being. They seem to be responsible for prolonged states of cheerfulness, happiness, joy, etc.

Sacral Innervations. The sacral division innervates the organs of the pelvic region largely by means of internal stimuli, such as the presence of waste matter in the colon; but many changes are produced by external stimuli. Handling or touching the sex or eliminative organs, produces a tension in the sex organs; and this usually arouses sex desire. There is, at least,

a tendency to continue or to seek a continuation of the stimulation. Sacral functions are thus a basis for sex excitement, desire, and passion, as well as intercourse and reproduction. These do not appear to be injurious changes, unless stimulated excessively, but the tendencies or desires produced by them often prompt children to engage in undesirable practices if they are not carefully trained.

SYMPATHETIC INNERVATIONS. Innervations through the sympathetic division occur in connection with such emotions as fear, anger, rage, grief, and sorrow. Fear and rage are accompanied by somewhat violent changes; but grief and sorrow, bodily pain, and other forms of suffering are accompanied by depressed activities. In *fear* there is a violent increase in the following functions: heartbeat, blood pressure, breathing, thyroid and adrenal secretion, liver output of blood sugar, clotting qualities of the blood, and the sensitivity of the muscles to nervous energy; but there is a checking of digestion and the glands related to it. In *rage* breathing is deep and rapid, heartbeat is violent and labored, the blood vessels of the face and limbs are distended, the face is flushed or pale, the adrenal glands are active, and digestion is blocked. Organic processes during *grief* and *sorrow* seem to be at low ebb; digestion is impaired, blood pressure is lowered, breathing is usually slow, and all energy producing mechanisms fail to function.

The tendencies produced by these changes are varied. In fear there is a strong tendency to flee, escape or hide from, or to push away the fearful object, to refuse to approach it, to seek the protection of others, to cry out, and to avoid the presence of the object. The effects may linger to produce in the individual the tendency to be startled at a slight sound, to be suspicious of other objects, and to be despondent. In *rage* there are tendencies to get rid of the stimulus, to attack and fight, to disobey or rebel against the offender, if a person; to be sullen, resentful, unsociable, and irritable, and to seek revenge or to do harm to the object. During *grief* and *sorrow*, there are tendencies to be helpless or dependent upon others, to refrain from energetic action, to weep or cry, to be alone, etc. The changes that produce all these tendencies are usually very harmful to the individual, especially if they are experienced frequently.

Glandular Secretions. A number of the visceral changes that have been mentioned appear to be the effects of secretion of the adrenal glands. Adrenin is present in the blood during fear, horror, and rage. This chemical causes the liver to secrete an abnormal amount of blood sugar, which adds strength to the striped muscles. It causes the blood to clot more rapidly, increases the oxidation processes in the muscles, the rate of breathing, and the size of the sacs of the lungs. It helps to neutralize the acid character of the blood produced by the activity of the muscles, and thus tends to lessen fatigue during violent action. It seems to mobilize an energy-giving compound found in the brain cells. This compound is known to exist in brain tissue because of the presence of Nissl substance, a substance composed of *granules* which are abundant in rested nerve cells, but which are reduced in number and disorganized when the cells are exhausted by excessive stimulation. During extreme fear or rage these cells are abundant, but afterward they are quite scarce. This indicates that excessive emotional stimulation increases the energy output of the brain at first, but soon exhausts it. Adrenin seems to be instrumental in liberating this stored-up energy. (4)

The *thyroids* are most active in fear. The presence of thyroxin seems to make the brain cells more responsive, to heighten the conductivity of the nerves, and to help in increasing the temperature of the body. Injected into a normal animal, thyroxin produces most of the internal disturbances observed in fear. In strong emotions the thyroids enlarge, and if the emotional strain is continued, they tend to become over-active. When this occurs the victim screams at the slightest pain, starts at the slightest sound, and constantly exhibits other symptoms of extreme fear.

Constant emotional stimulation would thus deplete or disorganize the adrenals and thyroids, break down the reserve strength of the nervous system, and cause numerous other physiological disorders. Individuals who are under the strain of the "sympathetic emotions" for a long period of time often suffer from a "nervous breakdown." This is characterized by insomnia, exhaustion, irregularity of heartbeat, difficulty of breathing, and general emotional instability. Such a "break" may result from continued worry, fear, or anger, but it results

most often from worry. Organs that are weak or defective for any cause are usually those most readily aroused by sympathetic action; and this accounts for the fact that persons who are sick or in ill health, hungry, or otherwise physiologically disturbed, are easy to arouse emotionally.

Glands that are *inhibited* by the sympathetic but *innervated* by the parasympathetic system include the salivary, pancreas, tear, and sex glands. During the "sympathetic emotions," as noted above, digestion stops, the mouth becomes dry, the sex organs are difficult or impossible to arouse. During "parasympathetic emotions," on the other hand, all of these functions are heightened in a positive manner. (1, 4, 7, 9, 12)

Somatic Responses

The somatic responses that occur in emotional reactions are: (a) instinctive acts which occur immediately following stimulation, and (b) instinctive or acquired patterns resulting from the different tendencies which are experienced as a result of the visceral changes. We shall be concerned here with the first group; later, attention will be given to the second. The instinctive acts that follow emotional stimulation appear to be chains of reflexes aroused directly by the stimulus or by the visceral processes and feelings. These usually appear as: (a) expressions of the face, (b) vocal motor responses, (c) posture and movements of the body, and (d) movements and positions of the limbs. As examples of many others, we may call attention to those that occur in (a) affection, (b) anger, and (c) fear.

AFFECTION (PLEASURE OR LOVE). *Face:* eyes bright, open, focused on attractive object; *brows* raised or level; *vocal motor:* crooning, gurgling, etc., pleasant, friendly sounds or speech; *voice* calm and low, clear and hearty; *posture* and *movements of the body:* posture relaxed, comfortable; leaning toward or against the attractive object; walking or running toward it; *position* and *movements of the limbs:* hands relaxed, or spread out as in patting, protective gestures; caressing or embracing; striking, kicking or biting to protect the beloved object.

ANGER (RAGE). *Face:* brows contracted, eyes narrowed; brows raised, eyes wide and glaring; brows level, eyes fixed, glance cold and steady; *mouth:* closed, lips thin, jaws set; mouth opened, wide as in loud speech; mouth opened slightly, lips

curled or twisted; nostrils distended; face flushed, pale or blotched in appearance; perspiration on forehead and upper lip; *vocal motor:* nasal and gutteral sounds, voice loud, hoarse or low and threatening; *posture* and *movements of the body:* erect, rigid, or slightly crouched and bent forward; trembling, running toward or throwing body against offending object, spitting at or upon object; *position* and *movements of the limbs:* fists clinched, fingers claw-like, emphatic gestures of arms accompanying angry sounds; pulling hair, striking, kicking offending object.

FEAR (HORROR). *Face:* eyes staring, brows raised, mouth open, lips quivering, nostrils distended, pale, possibly flushed, cold perspiration; *vocal motor:* cries and screaming expressive of pain or distress, or prohibitive commands; voice husky, loud, high or hushed and low; *posture* and *movements of the body:* body rigid, and motionless, or crouched and withdrawing; trembling, shivering, erecting of hair; drawing or shrinking away, or headlong flight; *position* and *movements of limbs:* hands clinched or shaking; arms thrust forward or thrown upward toward the face as if to push away or ward off the fearful object; or actually pushing away the fearful object, striking, kicking, and fighting. (1, 9)

Nature and Values of Physiological Processes

General Characteristics

The gross bodily movements indicated above appear to be natural, prompt reactions to emotional stimuli. Some of them appear to be reflex in character, in that they are prompt and certain to occur, but they differ from reflexes in being more complex and modifiable. That is, we can expect some such responses to occur in each individual, but the special patterns into which they fall may not be the same in different individuals; in fact, there are considerable variations when different individuals are observed. The strength or violence of the changes varies with different emotions and, as we have seen, with different individuals. In affection, for example, all the changes are of a mild character, until an offending object threatens to remove the beloved object; then affection is mixed with anger, and the reactions vary accordingly. In fear and rage, on the other hand, both visceral and somatic disturbances are violent.

The entire organism is aroused to such a degree that it is possible to engage in vigorous action for an indefinite period of time. Variations of these processes in different individuals appear to be due to inherited factors which determine the relative emotionality of different individuals. In one person the changes are very mild, regardless of the character of the emotion; in another, they may be relatively violent.

Values

The visceral processes seem to be designed by nature to predispose the individual to varying degrees of violent and sustained action. They either render the individual incapable of action, as in grief or extreme horror, or they furnish the vitality for unusually vigorous and sustained action. Their usefulness, of course, depends upon the nature of the situation. In crises or emergencies, as Cannon points out, these changes appear to be of considerable value. There is grave danger, however, in their being misused or over-used, even in emergencies. In such a case, a person's vitality may be exhausted, his energy dissipated, and his health impaired. Except in extreme instances, therefore, one should depend upon carefully controlled habits to adjust to emergency situations. The violent turmoil of fear, for example, will not save one from car wrecks, hold-ups, sinking ships, falling airplanes, and numerous other emergencies. In these one needs a clear mind, disciplined by previous training. The loud noises, which may have been a type of primitive emergency, do not mean danger very often in modern society; they more often suggest work to do.

The somatic responses involved in emotional reactions serve several useful purposes. (a) They serve as outlets for the pent-up energy developed by the visceral changes. Individuals, as a rule, should laugh, cry or weep, make movements and emit sounds, and the like, when they are specially prompted to do so. To be forced to inhibit any of these, when the tendencies have been aroused, is a painful experience, to say the least, especially in young children. Gradually, of course, individuals must be trained to modify these responses in terms of the demands of society, to the extent, at least, of restraining unsocial or dangerous modes of behavior. How to affect this type of training constitutes one of the chief problems of education. (5, 7)

Facial expressions, bodily postures, and vocal patterns have some value as means of social communication. The expressions accompanying the pleasurable feelings and emotions, such as smiling and laughing, are a type of invitation to other persons to approach or to continue their present mode of behavior. They say to the other person, in substance: "I like what you are doing; I want you to continue. Your behavior amuses me. I like you," etc. Add to these such expressions as are prompted by sacral processes, and we have the forms of communication used by individuals of the opposite sexes. Flirtations, coquetry, and the like are examples. The expressions of rage, disgust, contempt, and scorn are clear cut "invitations" to be gone. The sneer of contempt, for example, has been interpreted to mean: "I don't like you; please go away." The expressions of grief, sorrow, and pain have the effect of enlisting the assistance of others. Those of pity, sympathy, kindness, etc., indicate a willingness to render assistance, if possible. These have been called the tender emotions. Bodily expressions of the various types, therefore, serve as a means of communicating affective states, and by them human beings, as well as animals, exercise control over one another. They are probably the only forms of communication known to animals. (1)

Experimental Studies of Bodily Expressions

Variations in Patterns

At one state in the development of information concerning facial expressions and bodily movements in emotional reactions, it was believed a very definite pattern of movements accompanies each emotion. If this were the case, one could study each separate pattern and eventually learn to interpret the reactions so as to know the emotions present in an individual without knowing the stimuli which aroused them. After making various experimental studies, investigators have come to the conclusion that this claim is somewhat exaggerated. Some have even gone so far as to assert that there is no one particular pattern registered by individuals in any emotional reaction, and that observers cannot expect to learn how to interpret different expressions. The truth regarding bodily expressions seems to lie about half way between these claims. In other words, there

seem to be certain general patterns that are associated with various types of emotional reactions, but no two individuals exhibit exactly the same patterns in any particular reaction. Moreover, experiments show that both children and adults acquire the ability to interpret the bodily expressions involved in particular reactions. Attention may be called to some of the experimental findings.

Gates' Study

Gates made an effort to determine the accuracy with which children can interpret the expressive reactions of adults when these reactions are portrayed in photographs. He found that at least three-fourths of the children at different ages recognize certain expressions. These are: amusement, laughter, and glee by the age of three or four; anger, rage, pain, and suffering by the age of six or seven; horror by the age of eight; defiance by the age of eleven; surprise and amusement by the age of twelve; wonder, admiration, and suspicion by adults only. The growth in this ability was found to be clearly related to growth in ability to co-operate with others, to carry on school projects in conjunction with others, and to control emotional reactions.

Such findings indicate that the interpretation of facial expressions is an important factor in social adjustment. One who never performs an act will probably always have difficulty in knowing how others feel, and, consequently, will have difficulty in adjusting to the emotional experiences of others. If this inference is correct, a valuable service could be rendered children by training them to interpret bodily expressions. (3)

Guilford's and Blake's Studies

Guilford made a study the results of which indicate that individuals can be trained to interpret facial expressions. Subjects who were given special training for ten days, with a test every other day, made an average gain of 51 per cent over their original ability to interpret expressions. Though widely different at the start, the subjects became nearly equal as training progressed.

Blake compared the abilities of adults and children in interpreting facial expressions. He found that adults are superior to seventh-grade pupils. This indicates that the ability increases

with age without special training, a fact that is also suggested by Gates' findings mentioned above. (3)

Blake's Study

The significance of bodily expressions, other than facial, has been emphasized by Blake. The subjects were asked to name the emotion exhibited in pictures showing the whole body, and in other pictures showing particular parts of the body. The results indicate the relative value of body parts in expressing emotions. It was found that one interprets pictures with the greatest degree of certainty when observing the whole body, including the face. Next in value for interpretation is the whole body without the face; next the torso with the arms; next, the base of the body, including the feet, knees, and hips; and last, the head and shoulders, excluding the face. The face, of course, is the most expressive of all the parts of the body. (3)

Busby's and Ruckmick's Studies

Busby found that the upper part of the face, the eyes and brows, was more important than the mouth as a basis for interpreting emotions. He also found that adults are least successful in interpreting reactions exhibiting the following: egotism, embarrassment, antagonism, tenderness, stealth, resignation, and feebleness, in the order named.

General Conclusions

(a) Adults are more successful than children in interpreting various expressions. (b) Individuals can be trained to interpret more effectively. (c) The primary reactions are easier to recognize than are the secondary, by both children and adults. Expressions of secondary emotions contain many similar elements, making them difficult to identify separately. (3)

Application

As a means, then, of discovering signs of unusual emotional states and attitudes in pupils, the teacher should study their bodily expressions as a whole. Daily practice in watching and studying pupils, especially by asking them questions, will assist her in dealing with individuals. It will also enable her to detect most of the primary emotions, as well as pain and suffering. A

study of photographs used in experimental investigations may be helpful in learning to recognize many of the secondary-complex emotional states. In dealing with children who are problem cases, the teacher should watch for expressions, not only of emotional states, but also of malnutrition, lack of understanding, guilt or innocence, etc.

What Facial Expressions Do Not Show

Some things that facial and bodily expressions do not reveal by observation, popular notions to the contrary, notwithstanding, are: intelligence, teaching ability, ingenuity, probable teaching success, character, and various other traits which interviewers often think they are able to determine. What one discovers in an interview, that is of prime importance, is the attractiveness of a person, manners of dress, and whether the person is ill at ease. (3)

SOCIAL TENDENCIES

Description

General

Social tendencies were previously described as urges, cravings, or drives aroused in an individual by other persons or their activities. They include the tendencies to play, to congregate, to compete and excel, to secure social approval, to avoid social disapproval, to collect or hoard, and many others. One satisfies such tendencies by engaging in activities suggested by the names that describe them, which activities may include a large variety of acquired patterns.

Physiological Bases

Any effort to trace a social tendency to a tissue need or to a physiological process is disappointing. One usually concludes by discovering that any one tendency probably arises as a combination of physiological and emotional tendencies modified through experience. At any rate, there are no specific stimuli for them, such as those which arouse emotional tendencies; and there are no somatic expressions characteristic of any particular tendency.

Inheritance of Social Tendencies

Are social tendencies inherited? Do they appear in individuals, as do physiological and emotional tendencies, apart from the influence of previous training or experience?

The Old View

Many psychologists in the past have answered these questions in the affirmative, pointing out that such tendencies are universal traits, or characteristics of the species, and that they appear as definite instincts. At any rate, in the lists of instincts found in older textbooks, social tendencies occupy an important place. Moreover, educators have generally accepted them as inherited traits and stressed their importance in teaching, asserting that they are the starting point of all education and the bases of wants throughout the world. While such emphasis may be justified from some standpoints, there is some doubt as to the basic character of these tendencies.

The New View

In other words, more recent trends in psychological thought indicate that social tendencies, and the forms of behavior through which they are expressed, are acquired traits. The arguments for this view may be stated as follows: (a) None of the social tendencies appears in recognizable form at birth, but one may appear at a later stage in life long after the individual has had opportunity to learn it. (b) Their appearance in different individuals is not in connection with structural growth, development, and maturation, but in connection with social practices and corresponding personal interests. (c) No one tendency manifests itself as a mental state produced by an inherited physiological process, but as a product of observation, past experience, or anticipation of pleasure to be derived from engaging in a particular form of behavior. (d) Social tendencies are somewhat transient and variable; that is, they atrophy with disuse and with lack of encouragement, and grow stronger with use or expression. (6)

In brief, the appearance and operation of social tendencies appears to conform more to the nature of acquired than to the nature of inherited traits. Therefore, we shall defer discussion

of these tendencies to a later section devoted to the nature of acquired traits.

LAWS GOVERNING THE OPERATION OF TENDENCIES

Basic Principles

Before passing to a consideration of other matters, we may consider certain basic principles that seem to govern the operation of all tendencies. These may be stated as follows: (a) In general, to strive for the satisfaction or expression of a given tendency gives rise to pleasantness, and the acts of striving are satisfying. (b) Not to act when a tendency is being experienced is annoying. (c) Interference with an activity leading to the satisfaction or expression of a tendency produces conflict. (d) Prolonged, violent conflict results in the acquisition of an abnormal type of behavior. These principles will be illustrated later. (7)

Educational Practices

In terms of the foregoing principles, educational practices should: (a) indicate to each individual the ways that society requires him to satisfy his tendencies; (b) assist him in avoiding conflicts; and (c) reveal and remedy any abnormal forms of behavior that may appear as a result of accidental or unavoidable conflicts. These statements suggest the arousal of tendencies as motives in all school work, as a means of making school work interesting, absorbing, and joyous.

EXERCISES

1. Make a list of the processes that produce a physiological tendency.
2. Describe the events and processes that give rise to an emotional tendency.
3. Distinguish clearly between the James-Lange, Behavioristic, and Emergency Theories of Emotion. Present several arguments which favor or oppose each theory.
4. Make a diagram or series of diagrams illustrating the pathways of nervous discharge involved in emotional reactions.
5. Make a table showing a variety of visceral changes produced by nerve impulses discharged over each of the three divisions of the autonomic nervous system.
6. List the emotional tendencies that usually occur in connection with love, fear, rage, and grief.

7. Why is it important for prospective teachers to become acquainted with the visceral changes which occur in emotional reactions?
8. Summarize the values to a teacher of a knowledge of the somatic responses that usually take place in emotional reactions.
9. What are the most important facts brought to light by experimental studies of bodily expressions?
10. Discuss the values of emotional tendencies as motives for school work. Should the teacher arouse emotional tendencies as a means of getting children to do school work? Why?

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PART III

LEARNING

Purpose of Part III

Review

So far in this book, we have dealt mainly with the structures, functions, and capacities with which human beings begin life and which appear at different stages during a long period of growth and development. These traits, as we have tried to show, constitute the biological endowment with which the individual attempts to adjust to his environment. Whatever the individual does apart from the influence of environment, experience, or training has been represented as *inherited behavior;* whatever he does as a result of these influences has been called *acquired behavior.*

Future Problems

Since we have dealt mainly with inherited forms of behavior, we shall now deal with the acquired forms. An effort will be made to show what the different acquired forms are; how they arise without and with special guidance; the factors that operate in determining particular patterns; and how teachers or other educators can utilize these factors in arriving at particular goals set for the individual.

Preliminary Description of Learning

As Adjustment

Acquired forms of behavior are the products of *learning.* Learning is, therefore, the process by which individuals acquire new forms of behavior. In learning, one either modifies some inherited pattern or acquires a new pattern. Most learning in early life is the process of modifying original nature; learning in later life is largely the acquiring of new patterns of behavior.

All learning is related to the efforts of the individual to adjust to his environment by reacting to particular situations. At least the process takes place when the individual is confronted with a situation to which he is at first unable to adjust. When confronted with such situations, and motivated by the effects of the situation on his sensitive equipment, or by some tendency, the individual reacts and thus tries to adjust. As he does so, he learns, and by learning eventually acquires patterns of behavior that will meet the requirements of the situation and the demands of particular tendencies; or else he will fail to adjust and thus organize some conflicting patterns. Although, while learning is the process by which the individual adjusts, it is not the same as adjustment; for by learning one can become maladjusted.

As the Formation and Elimination of Connections

Because learning leads both to adjustment and to maladjustment, it is sometimes described as the forming, strengthening, weakening, and eliminating of connections between definite stimuli and specific responses. A response is said to be connected with a stimulus if it occurs, or tends to occur, each time the stimulus is presented. A strong connection insures an invariable occurrence of an acquired response to a particular stimulus. If a connection is weak, the response may or may not occur when the stimulus is presented. A connection is eliminated when a particular stimulus invariably fails to call out a response to which it was previously connected.

From the standpoint of educational practice, learning should be directed to the end that desirable connections will be formed and strengthened and undesirable ones weakened and eliminated. How this process is accomplished is largely the subject matter of the sections of Part III.

Plan of Discussion

Learning is such a complex process that several chapters will be required to describe it. Chapter VIII will deal with the objectives, general nature, principles, and types of learning. Beginning with Chapter IX, each of the types of learning will be described in some detail for the purpose of showing the factors that operate, as well as showing how educators can assist pupils in various particular instances.

CHAPTER VIII

OBJECTIVES, PRINCIPLES, AND TYPES OF LEARNING

INTRODUCTION

Purpose of Chapter

Since the purpose at this time is to present a treatment of the general features of learning, the student should read this chapter as a background for those that are to follow. After reading the chapters on the specific types of learning, the student will find it profitable, perhaps, to turn back and reread this chapter as a review. Such performance will, at least, keep the student from being confused by the discussion of a very complicated process.

OBJECTIVES OF LEARNING

Meaning and Types

By "objectives of learning" is meant the aims, ends, or goals in the mind of the learner, or in the minds of educators who are directing the learning process. Objectives which the learner has in mind may be designated as *individual;* those which educators have in mind for the learner to reach are either *social* or *psychological. Social objectives* are those conceived by educators as being the end results of all education and training. *Psychological objectives* are those that educators or teachers may have in mind when they deal with specific cases of learning. That is, social objectives are general, and psychological objectives are specific aims. We may study these in some detail.

Individual Objectives

Immediate

The immediate end result of any particular instance of learning is usually the satisfaction of a particular tendency or drive.

In a previous chapter, for example, attention was called to the striving activities of young children represented as motivated by particular tendencies. Nearly all learning in the very young child is of this type. He tries to get or obtain things that will satisfy his wants, and in striving to do so, he learns.

Remote

As a child increases in age, he discovers that certain types of behavior will be useful to him in the future. He wants to be and act like adults, for example, and he is willing to engage in learning activities that will eventually enable him to be and to do what he desires. Thus the individual has a remote aim in view. To indicate what each of these might be in the case of a particular individual would require a volume.

Social or General Objectives

The Seven Cardinal Principles of Education

The general objectives of learning are, as indicated above, the general aims of education. These are usually grouped under the following headings: (a) health, (b) practical efficiency, (c) good citizenship, (d) worthy use of leisure time, (e) vocational efficiency, (f) worthy home membership, and (g) international understanding. These are known in educational literature as the "seven cardinal principles of education." Translated into more concrete form, they imply that educators should give each individual pupil instruction and training in (a) maintaining life and keeping well, (b) using the tools of civilized society, (c) cooperating with others in social and civic enterprizes, (d) using leisure time for enjoyment and enrichment of life, (e) finding and following a vocation, profession, or trade to make himself economically independent, (f) making and maintaining a home, and (g) understanding and appreciating peoples of other races and nations and their contributions to civilized society. (10)

Social Efficiency

All of these aims, it is generally believed, constitute *social efficiency*, which has been emphasized as the chief aim of all education. In a democracy, especially, education has not completed its task when it has equipped the individual with modes

of behavior which will enable him to survive; it must develop the individual so that he will contribute something to the welfare of the society in which he lives. He must, in other words, be made as efficient as his capacities will permit. (10)

Psychological Objectives

While the general objectives are the chief general aims that a teacher should work toward, they do not represent the specific problems confronting an educator. What an educator, a teacher in particular, needs to keep in mind is the immediate outcome of the child's behavior involved in his effort to react to a given situation. When we think of the outcomes of learning from this standpoint, the objectives are specific patterns of a psychological nature. These patterns are usually designated by such terms as: (1) Habits, including (a) modified reflexes, instincts, feeling states, emotional reactions, tendencies, and other inherited functions; and (b) such products of these modifications as attitudes, ideals, interests, tastes, and appreciations. (2) Skills, including (a) motor, and (b) semi-motor performances of a highly complicated nature. (3) Knowledge or information in the form of (a) percepts, (b) images, (c) ideas, (d) concepts, and (e) inventions. Each of these terms has a fairly definite meaning, or reference to a fairly distinct pattern of behavior, which we shall have occasion to present and describe later. The student has enough information at hand to understand the general nature of these psychological outcomes of learning.

Social Character of Psychological Outcomes

Conformity to Social Patterns

The types of outcomes set forth above are by no means independent of each other. The social objectives are simply the general directions that the psychological objectives should take. Thus, it may be seen that the final character of a specific pattern of behavior should be definitely social. That is, habits of all kinds, skills, percepts, ideas, and attitudes must all be made to conform to social approval before individual adjustment is achieved. Every specific habit, for instance, should be patterned after the models approved by society; attitudes, ideals, appreciations, and the like must conform, to a certain

extent, to social standards; and even the ideas one acquires must have the general sanction of society before they are considered worth while. In brief, almost all human acquisitions, motor or mental, must conform to social custom, convention, law, and other standards of thought and conduct.

Tasks of Educators

In view of the aims or goals to be attained in dealing with pupils, the teacher is confronted with the task of (a) getting acquainted with both the social and psychological objectives, and (b) mastering the techniques of guidance, training, and instruction that will enable her to direct the pupil toward attaining them. Having become familiar with such matters, the teacher is then confronted with the following specific tasks: (a) confronting the pupil with the stimuli to which it is desired he should react; (b) motivating him to react in a vigorous manner; and (c) directing, restraining, and controlling specific reactions until they are organized into desirable patterns. Moreover, if undesirable patterns appear in the child as a result of previous chance or ill-directed performance, the teacher is confronted with the task of modifying or completely eliminating these patterns from the pupil's stock of acquisitions.

THE SYNAPSE THEORY OF LEARNING

General Statement

While learning may be described as the process by which adjustment to environment is achieved, or as the process by which connections between particular stimuli and responses are formed and eliminated, a more fundamental view of the process is expressed in what is known as the *synapse theory of learning.* This theory is an explanation of learning as the formation and elimination of functional connections at the synapses of the nervous system. This is a *physiological explanation* of learning rather than one based on the observation of behavior patterns. It is not a contradiction of other explanations but an effort to show specifically what goes on in the learner while learning is taking place. The theory is based on certain facts regarding the nature of nervous tissue and the transmission of nervous energy from receptors to reactors.

Neural Pathways

The Reflex Arc

In the previous discussion of reflexes, the neural arc was described as involving a relatively simple group of organs. These are: (a) a receptor or group of receptors, (b) a sensory neuron, (c) a synaptic connection in the central nervous system, or in the ganglia of the autonomic nervous system, (d) a motor neuron, and (e) a reactor. This is thought to be the simplest and most fundamental pathway that nervous energy has to follow when impulses are initiated by definite stimuli. Through learning, however, two or more stimuli can be related to a reflex activity, and any stimulus can be eliminated. When this is accomplished, there is a series of new connections formed; so that nervous energy can be switched from different receptors to a single reactor. For example, the blinking reflex, which is called out at first only by contact stimuli, can be attached to visual and auditory, and possibly to olfactory, gustatory, and kinaesthetic stimuli. How this is accomplished will be described later.

Convergence

When new connections are formed so that several stimuli will elicit the same response, the phenomenon of *convergence* is pos-

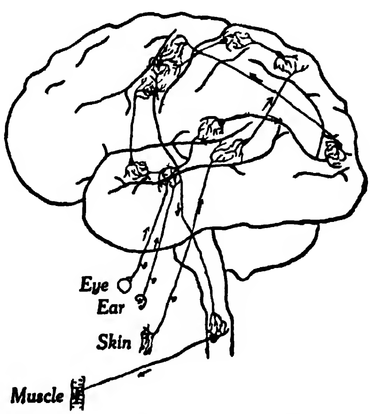

FIG. 26. Illustrating the phenomenon of convergence, by which the nervous energy from the ear, eye, and skin may be discharged into one muscle.

sible. This occurs when two or more stimuli presented simultaneously elicit a joint response. For example, the taste of food

will cause the salivary gland to start secreting. Through the process of learning the salivary secretion can be attached also to the smell, to the sight, or to the touch of food. Now if all these stimuli are presented at the same time, after the new connections are formed, there is a greater or stronger flow of saliva than there is when only one stimulus is presented. This fact indicates that the nervous energy from the various receptors *converges* and finds an outlet to a single reactor. This implies, moreover, that the organism can be trained to react in a simple way to a number of stimuli acting at once; and that this is accomplished by forming a new series of nerve connections between the various receptors and the reactor involved in making the simple response. (See Fig. 26.) (4)

Diffusion

When the organism is stimulated by an intense stimulus, the characteristic response is a complex pattern. Jumping or crying

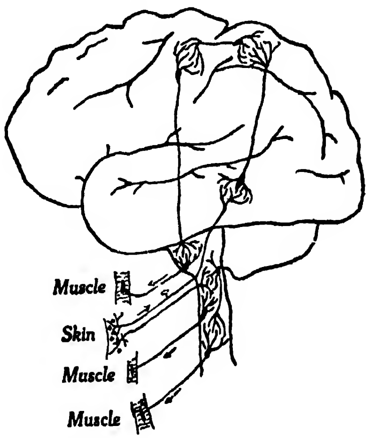

FIG. 27. Suggesting the phenomenon of diffusion, in which the nervous energy is distributed from one receptor to various reactors.

from being stuck with a pin, the complex fear response to a loud noise, and becoming very angry when held, are examples of what is meant. Here, in each case, it may be observed that while only one receptor is stimulated, a number of reactors are aroused to action. It thus appears that the nervous energy initiated at this receptor spreads or *diffuses* to a large number of reactors. This phenomenon or process is known as *diffusion.*

It is made possible by the elaborate system of connections in the spinal cord and cerebellum. A single sensory axon may carry the nervous energy to the spinal cord, but upon reaching the spinal cord the nervous energy divides and is transferred to various other centers, including the sensory areas of the cortex, and from these centers impulses are distributed to the numerous reactors involved (Fig. 27). Diffusion occurs typically in nearly all instinctive reactions, but it may also be made to occur in acquired reactions. For instance, to the command, "Halt!" the well-trained soldier understands the word, and comes to an immediate stop, all of which involves the transference of nervous energy from the ear to a great many reactors. In organizing this type of response, many new connections by which such diffusion takes place have to be formed. (4)

Facilitation

The description of convergence and diffusion implies that the nervous system enables the organism to respond vigorously to some stimuli and less vigorously to others. On the whole, however, the vigor of a response depends, in part, upon the number of receptors stimulated. Except in somewhat unusual instances, one does not respond to one stimulus but to many, and not with one reactor but with many. Typically, therefore, one responds *as a whole* to numerous stimuli acting at the same time. It has been observed, moreover, that two or more receptors stimulated simultaneously will occasion a more vigorous response by the organism as a whole than will a stimulation of one receptor. This phenomenon is known as *facilitation.* In this it appears that the nervous energy from the various receptors combines in the nerve centers in such a way as to increase its vigor and capability for arousing the various reactors. In bringing about a particular reaction in learning, therefore, it is often necessary and desirable to present a combination of stimuli. (4)

Inhibition

Not all nerve impulses originating in the receptors reach the reactors. Many are stopped in the central nervous system, either by resistance at the synapses, or by nerve currents which have opposite effects on the same reactors. All synapses appear to

offer some resistance to the passage of nerve impulses. The amount of resistance seems to depend upon the closeness of the end brushes and dendrites and upon the extent to which they have been used. If the end brushes and dendrites are close together, an impulse may cross the synapse with little resistance. If these elements are farther apart, the impulse may meet with considerable resistance or be blocked entirely. The synapse is thus analogous to a narrow or wide gap in an electric circuit, which, when narrow, permits electrical impulses to cross, but when wide, blocks or stops them. If the impulse crosses the synapse with only a little resistance, the response is prompt and vigorous; if the impulse meets considerable resistance, the response is delayed or weakened; if the impulse is unable to cross the synapse, the response is *inhibited* or prevented from occurring at all. In most cases of inhibition, the impulses initiated are probably shunted out to reactors that the individual does not intend to use. This is why one performs many superfluous movements when he is attempting to learn a new performance, and why an individual is not able to perform a new function the first time he tries. (4)

Another type of inhibition occurs when two or more nerve currents, initiated at the same time, have opposite effects on the same reactors. This type is a very common occurrence, and is necessary for the proper execution of many necessary and useful activities. In fact, the movement of a muscle on any normal occasion involves a certain amount of inhibition. There is in each muscle, for instance, a certain amount of tonus or contraction due to nervous energy aroused by glandular secretions. If in this condition of partial contraction, a flexor muscle is thrown into greater contraction, the tonus of the extensor is inhibited, enabling it to relax. This phenomenon is called *reciprocal innervation.* A considerable amount of inhibition goes on among the reactors of the viscera as a result of inhibitory nerves belonging to the autonomic system. Impulses discharged from these nerves block or stop whatever activity is in progress.

There is also a considerable amount of inhibition of striped muscular activity effected by impulses from the cerebral cortex. This is accomplished by such factors as intention, purpose, trial, or effort. That is, by the exercise of volition, decision, or "will," the individual can direct the flow of nervous energy so as to

inhibit a response or group of responses already under way. This ability to inhibit muscles in action and purposely to control the direction of the flow of nervous energy, in turn, enables the organism to gauge the extent and accuracy of its movements. Indeed, one of the chief functions of the higher levels of the nervous system is to regulate and unify the activities by inhibition and excitation. In this manner a harmonious functioning of a group of muscles is obtained. If all of the numerous impulses from the eyes, skin, muscles, and internal organs that constantly stream into the cortex by way of the thalamus were to find a way out to the muscles and glands, the behavior of the organism would be chaotic and aimless. It may be seen, then, that inhibition, particularly from the cortex, plays an important part in regulating all of the activities of the organism. (6)

Integration

The innervation and the inhibition of particular reactors by cortical direction depends upon the process known as *integration*. This process is the combination and organization of neural excitations within the nerve centers and the direction of nervous energy to the reactors involved in an adaptive act. The conscious aspect of this process is deliberation and decision. For instance, an individual is often confronted with a situation containing stimuli that tend to arouse opposite or incompatible responses. Since both of these types of responses cannot operate at the same time, one must be inhibited in favor of the other, or both must be inhibited in favor of a third. While inhibition is in progress integration is also going on. That is, the individual is deliberating the possible courses of procedure and attempting to decide upon the most desirable one to take. When a decision is finally reached, action may be taken and the adjustment made. After the individual has acted in the same way in a number of similar situations, his adjustments are made without the necessity of making a decision. That is, he tends to make the adjustment immediately and directly without having to halt action each time the situation arises. In this case, *integration* has been effected. After this, the cortex more or less automatically receives impulses from the receptors and directs the nervous energy to the appropriate reactors. This aspect of cortical functioning makes possible the automatic character

of habitual behavior as well as specific activities based upon deliberation and decision. (4)

Co-ordination

In attempting to react to relatively complex situations, a learner finds it necessary to go through a long period of trial and error performance and drill. During this period, he attempts to get rid of persisting errors and to select only appropriate responses, and finally to repeat the same activity until it can be performed without error. Having succeeded in accomplishing this end, the learner can perform the activity with a high degree of speed and accuracy. All of the separate movements involved in the performance exhibit a high degree of *co-operation.* The neural processes that go on in this type of learning include all of those described above. The process of bringing about the harmonious coalescence of activity of individual muscles essential to orderly movement is called *co-ordination,* which process is necessary in the acquisition of all motor skills. The process is accomplished by opening up many new connections between the neurons, by closing many old connections that lead to erroneous responses, and by organizing definite pathways of nerve discharge.

Plasticity

Modifiability

The possibility of establishing particular neural pathways is due to the plastic nature of nervous tissue; that is, to its capability of being modified. When a nerve impulse makes its way through the nervous system for the first time, it not only overcomes some type of resistance, but it also modifies or changes the synaptic elements so as to break down the resistance. The change effected appears to be a molecular disturbance in the nervous tissue between the end brushes and dendrites. We refer to this change by the term *impression* by which is meant not an actual dent or path in nervous tissue, but merely a change in the arrangement of the molecules at these junctions. The effect of impressions is a greater readiness of the synapses to conduct subsequent impulses that seek outlets over the same pathways. That is, the more often a particular pathway is used or followed

by nervous energy, the less will be the amount of resistance it offers, and the greater will be the degree of modification effected at the synapses.

Retentiveness

The term "plasticity" not only implies modifiability but also *retentiveness* of nerve structure. This is the capability of nervous structure to retain impressions. The retentiveness of nerve structure is inferred from the fact that a function of any kind becomes easier to perform when practiced and is retained as a definite mode of behavior long after practice ceases. The greater the degree of modification effected by the use of particular pathways, the greater the degree of retentiveness. (4)

Plasticity and Learning

Learning takes place because of the plasticity of nerve structure. The greater the plasticity of the nerve structure of a given individual, the greater is the degree of readiness with which he learns. Since modifiability and retentiveness go hand in hand, it seems that an individual who learns fastest retains what he learns longest. This implies that plasticity is an inherited capacity basic to the capacity to learn and retain.

Implications of the Synapse Theory

While there are probably many aspects of learning that are not easily explained by the synapse theory, it is the most fundamental explanation of learning that has been proposed. It agrees perfectly with the reaction hypothesis and provides a basis for explaining the appearance of new reactions. The ideas of plasticity, synaptic resistance, lowering and removing resistance, forming, strengthening, weakening, and eliminating connections between stimuli and responses—all of these and related ideas likewise agree with experimental findings. In our future description and explanation of learning activities, we shall assume this theory.

LAWS OF LEARNING

Kinds of Laws

Another basic fact regarding the learning process, often over looked by teachers, is that it follows definite laws. Most teach-

ers are aware of the fact that all nature is governed by laws; that plants and animals live, function, and die in accordance with the laws of nature; but few seem to realize that this same principle holds true in the case of learning. That learning, whether animal or human, goes on in accordance with certain laws is now a recognized fact.

There are some laws that are *primary* or *general,* in that they are involved in all learning of whatever type. There are others that are *secondary* in that they appear only in particular types of learning. Both animal and human learning, for example, are thought to proceed along certain general lines; but human learning, being more complex and variable, involves factors that are not included in the laws that describe animal learning. Our purpose now is to state the primary or general laws, by way of getting an introduction to them; and later, in the discussion of different types of learning we shall show how these laws are involved in each type, and point out the secondary principles that have to be applied in directing each type. (4)

The Primary Laws of Learning

These are the laws that are descriptive of learning wherever we find it going on:

The Law of Readiness

When a learner is confronted with a stimulus to which a new response is to be made, the connection between that stimulus and the response will be established most quickly if the learner is ready to act.

This is known as the *law of readiness.* By "readiness" is meant a state or condition within the learner which urges or prompts him to act. This state may exist in the form of inherent sensitivity of the sense organs; in the form of a physiological set, as in the condition of hunger or thirst; in the form of a mental set, as when the individual is expecting to react in a given way; or in the form of an ultimate purpose, goal, or aim which the learner desires to attain. (4)

The Law of Repetition

Whenever a given activity is repeated as a response to a particular stimulus, other things being equal, a connection tends

to form by which the response becomes more certain, prompt, and easy. Moreover, continued use or exercise of that connection tends to strengthen it and to make it more nearly permanent. This principle is known as the *law of use*, the *law of exercise*, or the *law of repetition*. It is perhaps the best known and the most widely applied law of learning, and it is perhaps the most abused. As we shall see later, there are conditions under which repetition of an activity fails to result in learning.

There are several corollaries of the *law of use*. One is the following: An activity that is not used or repeated for a period of time tends to be forgotten, and the connections already formed are weakened or eliminated. This is known as the *law of disuse*. While the principle seems to be true in general, there are sufficient exceptions to justify the belief that the effects of learning are relatively permanent. Many facts apparently forgotten may appear after a number of years, and many skills can be performed more efficiently after a lapse of time than when the practice was in progress. Two other corollaries of the law of use are the *law of frequency* and the *law of recency*. According to the *law of frequency*, the more frequently an activity is repeated the stronger is the connection. This principle operates, of course, in the event that repetition has been effective. The *law of recency* is that, other things being equal, the strength of the connection between a stimulus and a response depends upon the recency of the use, or the absence of disuse.

All of these corollaries suggest the practical procedure of distributing practice over a long period of time instead of continuing it undistributed. Experimental studies have shown, for example, that a greater amount of learning takes place when one practices or studies fifteen or twenty minutes at a time each day for four days than when he practices or studies for a single period of sixty or eighty minutes. This practical principle is known as the *law of distribution of practice*. It is a very applicable principle and one that accounts for many of the effects of disuse. (4)

The Law of Contiguous Stimulation

If two or more stimuli leading to separate but compatible responses are presented at the same time, or in immediate succession, a connection tends to form between each stimulus in the

total situation and the responses that occur. This being true, a subsequent presentation of any one stimulus of the group previously presented will tend to elicit any one, several, or all of the responses which occurred in the total reaction. But if two or more stimuli presented contiguously lead to incompatible responses, a connection tends to form between the more potent or stronger stimulus-response unit, and the weaker or less potent connections tend to weaken or drop out. This is known as the *law of simultaneous stimulation*, the *law of conditioning*, or the *law of contiguous stimulation*. The last name appears to be the most appropriate, because it implies that the connections indicated will form when the stimuli are presented either at or near the same time, or when there is an interval of time between the two stimuli. Ample illustration of this law will be given in the next chapter on the subject of conditioning. (4)

The Law of Attention

Other things being equal, the forming and strengthening of the connection between a stimulus and a response depends upon the amount and degree of attention aroused in the learner by the stimulus. This principle is known as the *law of attention*.

The nature and importance of attention in behavior in general has already been emphasized. As we have seen, it is the first act of adjustment to any stimulus to which the individual consciously reacts. It may be shown that some types of learning take place unconsciously, without the learner being aware that he is adjusting to a particular group of stimuli, but this fact should not detract from the general requirement of attention in acquiring most of the outcomes of learning.

The Law of Effect

The discussion of *feelings* in an earlier chapter revealed that these mental states are the bases for positive and negative responses. There it was pointed out that pleasantness is a state of satisfaction or agreeableness within the organism resulting from a given stimulus acting on a receptor. Unpleasantness, on the other hand, was shown to be a state of annoyance or disagreeableness resulting from a given type of stimulus. An effort was made to show also that these states, after having been experienced in connection with a given stimulus, predispose the in-

dividual to react in a positive or in a negative way toward the stimulus on a subsequent occasion. Thus there is a general tendency in individuals to repeat those reactions which, on the whole, are accompanied by satisfyingness or pleasantness, and to avoid those reactions which, on the whole, are accompanied by annoyingness or unpleasantness.

The existence and nature of this general tendency has led to the formulation of the *law of effect,* which may be stated as follows: "When modifiable connections between a stimulus and a response are used, these connections are strengthened if the response is satisfying and weakened if the response is annoying." It may be seen that the law describes the *effect* of a response; that the law holds that pleasantness or unpleasantness, experienced in making a given response, has something to do with the strength of the connection. The law was originally formulated to explain why some repetitions are much more valuable than others for learning. It is now believed that the factors described by this law are covered by the law of *contiguous stimulation* presented above. The law is of considerable importance, however, as a practical principle. We know from experimental evidence, for example, that pleasant and unpleasant objects, or objects which persons report as being pleasant or unpleasant, are remembered better than objects which produce less noticeable effects. We know also that individuals tend to repeat actions which they report as being pleasant and to avoid those which they report as being unpleasant. Thus, these factors are important, not as strengtheners of connections, but as factors which predispose the individual to continue or to stop repeating a given performance. The *law of effect* is thus, in reality, a corollary of the *law of contiguous stimulation;* it is a secondary principle which emphasizes factors which are sometimes but not always involved in learning. As a practical principle, it should be remembered and used in teaching. (4)

The Causes of Learning

The laws of learning presented above describe the factors which influence learning in one way or another, but they do not, as some have thought, describe the causes of learning. The immediate cause of activity on the part of the learner is his inability to adjust to a particular situation when it is first

presented to him. This inability is due, in turn, to the lack of ready-made forms of behavior to meet the requirements of the environment. The individual is prompted or stimulated to respond to certain forces because he has a group of receptors that are sensitive to them, and because he has other structures which function when these receptors are stimulated. Moreover, the individual is capable of responding to more than one stimulus at a time, and because of the plasticity of nerve structure he is capable of retaining the effects of his own reactions. Thus, the basic causes of learning are: (a) the sensitivity of the receptors to certain kinds of stimuli; (b) the complexity and plasticity of nerve structure; (c) the lack of inherited forms of adjustment; and (d) the tendency to respond when stimulated. The basic conditions under which learning takes place are described by the *law of contiguous stimulation.* Important factors that influence learning are *use*, *disuse*, *readiness*, *attention*, and *effect.* (9)

TYPES OF LEARNING

Various Classifications

According to Objectives

When classified according to the goals or outcomes described above, learning may be divided into the following types: (a) sensori-motor, involved in the acquisition of simple habits; (b) perceptual-motor, involved in the acquisition of social habits and complex skills; (c) perceptual, involved in the acquisition of percepts and semi-skills; (d) conceptual, acquiring knowledge and understanding of abstract ideas; (e) associative, involved in memorizing and in forming connections between mental processes; (f) imaginative, employed in gaining knowledge of things beyond the range of sensory experience and in inventing, planning, or working out original ideas. These are the types of learning that we shall study in the chapters that follow. (5)

According to the Type of Learner

When we think of learning going on in different subjects, we have (a) *animal* and (b) *human* learning. The meaning of these classes is obvious. Human learning is frequently sub-divided as follows: infant learning, babyhood learning, childhood learning, and adult learning.

According to Bodily Organs Chiefly Involved

Frequently we wish to emphasize learning activities as involving chiefly muscular or mental activity. In this case, we have: (a) motor and (b) ideational learning. *Motor learning* is characterized as involving chiefly muscular activity. This type includes the sensori-motor and perceptual-motor types listed above. In these there is little mental and much motor activity. *Ideational learning*, on the other hand, pertains to the acquisition of ideas. In this type muscular activity is not involved to any great extent. From another standpoint, motor learning is objective, and ideational learning is subjective. Ideational learning includes those types classified above as perceptual, associative, imaginative, conceptual, and creative. (1)

Types of Learning and School Subjects

The types of learning in which we are chiefly interested are those that go on in school, particularly those involved in acquiring playground activities and the school subjects. For this reason, attention is called to the following summary of these relationships:

Types of Learning	*Products*	*School Subjects*
1. Sensori-motor	Simple motor habits, skills, and attitudes	Playground, nursery school, and kindergarten
2. Perceptual-motor	Social habits, complex motor skills	Handwriting, dancing, typewriting, vocal and instrumental music
3. Perceptual	Semi-skills, language meaning, object meaning	Drawing, nature study, sight singing, reading
4. Conceptual	Concepts, general ideas, rules, definitions, and principles	Grammar, science, and mathematics
5. Associative	Ideas, verbatim information, etc.	Spelling, languages, all subjects
6. Imaginative	Images and understandings of things not present	History and geography

In the chapters which follow we shall try to show the nature and principles of each of the different types of learning as exhibited in human learning.

Learning as Habit Formation

Meaning of Habit

The term *habit* is used to designate any special mode of acquired behavior that occurs each time a particular stimulus or situation arises. It is usually the outcome of reacting to a given stimulus a large number of times in approximately the same manner. When a habit has become definitely established, it remains relatively unchanged over an extended period of time, unless definite efforts are made to modify or to break it. Many authors restrict the meaning of habit to co-ordinated muscular activities, such as simple movement patterns and skills. Others extend the meaning of the term to include special ways of feeling and thinking that are characteristic of individuals. Since both of these types of acquired functions are outcomes of similar factors that operate in learning, we should think of habit in the latter or broader sense.

The expression *habit formation* should be taken to imply any learning process by which inherited functions are modified and organized into relatively permanent patterns and by which purely acquired functions, even of an intellectual type, become invariable or fixed characteristics of the individual.

Types of Learning Involved in Habit Formation

Because of the limitation of the meaning of habit indicated above, many authors regard habit formation as a special type of learning. In this text, however, habit formation will be regarded as a *continuation of any type of learning to the point that the learner reacts in a definite manner whenever in the presence of a given stimulus or situation.* In other words, any type of learning may result in the formation of a habit if it is continued long enough; or any reaction may become a habit if it is repeated often enough to become a fairly definite pattern of feeling, thinking, or acting peculiar to an individual. Habit should be the goal of any type of learning, therefore, when the specific mode of behavior being acquired is particularly useful to the

individual as a relatively permanent acquisition. Otherwise, habit is not a desirable outcome of learning. In many cases of learning, the individual is merely preparing to take a step forward in acquiring a higher order of behavior. In this event mastery should not be perfected to the extent of habit. This is particularly the case in the acquisition of various items of information. Here the learner must continue to modify his reactions through the accumulation of additional experiences so that items of information will continue to expand and become broader.

Transition

In the chapters that follow, we shall try to indicate the nature of each of the different types of learning, the principles that operate therein, and the tasks of the educator involved in helping the learner economize time and effort in acquiring different modes of behavior. We shall also try to show how each type of learning is involved in the mastery of the school subjects, and how each may be directed so as to result in the formation of desirable habits.

EXERCISES

1. Why is it of value to have such statements as the "General Objectives" of learning? Why have "Psychological Objectives"?
2. What is meant by the social character of learning? Is there any learning that is not social? Discuss.
3. What is meant by the physical or neural basis of learning? Does mental activity have a neural basis? Discuss.
4. Illustrate convergence, diffusion, facilitation, and inhibition.
5. Why should the school take particular care to supervise the school contacts of the new pupils, as well as all activities of the first day of school each year?
6. It has been said that "Learning is an inescapable condition of living." Explain, and justify or criticize.
7. From what you know of the laws of learning, discuss this statement: "Practice makes perfect, if there is enough of it."
8. Give an illustration from your experience in which bad impulses have actually been rewarded. Does this render the Law of Effect ineffective? Why?
9. What determines whether a thing is satisfying or annoying? Are there any situations that are neither satisfying nor annoying? Illustrate.
10. What do we mean when we say that the human nervous system is plastic? Does this differ with different ages? Discuss.

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CHAPTER IX

SENSORI-MOTOR LEARNING

INTRODUCTION

Meaning

Limitation of Meaning

Some authors mean by "sensori-motor learning" the acquisition of all motor performances, including such complicated skills as handwriting, typing, piano playing, and handling tools. It is our purpose here, however, to limit this type of learning to the acquisition of much simpler motor habits and skills. The acquisition of complex skills is more accurately described by the terms *perceptual-motor* learning. In this the learner is not only confronted with the task of acquiring muscular activities but also of acquiring various mental products. For instance, in learning to play a piano, the pupil must learn to recognize many symbols employed in music, such as notes of various kinds and lengths and their positions on the staff; and then he must learn to attach to these symbols various movements, such as those of the hands on the piano key board. In this type of learning the motor performance is brought under control of a thought process. In *sensori-motor learning,* on the other hand, the task is not so complicated. It is largely that of attaching muscular responses to sensory events the meanings of which do not have to be apparent. In other words, the pupil is not highly conscious of the stimulating conditions in the sense of knowing what to do before executing the performance. He responds to the situation simply because there are certain potent forces that act upon his sensory equipment or because there is some motive that makes the situation effective in eliciting the responses to sensory experiences rather than the attachment of motor responses to perceived or meaningful aspects of complicated situations. The latter type of learning will be discussed in a subsequent chapter.

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Types of Sensori-Motor Learning

The term "sensory" pertains to the activity of receptors and afferent nerves and to the sensations arising from stimulating them. The term "motor" refers to the activity of motor nerves and muscles or the movements produced by them. Sensori-motor learning, therefore, is the connection of muscular responses with particular stimuli or situations. When a ready-made muscular response, such as a reflex or instinct, is attached to a given stimulus or to several different stimuli, the learning is designated as *conditioning*, and this is usually considered the simplest of all the different types of learning. When a muscular performance is acquired, or established as a definite pattern of behavior, and attached to a given situation or series of situations, the learning is called *co-ordination*. Though more complex than conditioning, this type of sensori-motor learning appears early in life and is important as a means of acquiring numerous motor habits and simple skills.

In the pages that follow, an effort will be made to describe conditioning and co-ordination in such a way as to indicate the manner in which reflexes and instincts are modified and simple muscular skills are acquired. We shall be concerned not only with the processes involved in each type of sensori-motor learning but also with the factors that educators may find helpful in directing the acquisition of various activities.

CONDITIONING

Definitions of Terms

Pavlov's Experiments

As suggested above, conditioning may be tentatively defined as the process by which ready-made responses are attached to new stimuli. By "ready-made" responses is meant all inherited forms and such acquired forms as may exist at the time a particular case of conditioning takes place. Most of our knowledge of this process is the result of the researches of the Russian scientist, Ivan Pavlov. About 1904, this scientist performed a number of experiments on a dog, in which the salivary reflex was set off by a number of different stimuli.

Pavlov noticed, first, that the presence of food, such as meat,

in a dog's mouth increased the flow of saliva. Then he noticed that a similar increase took place when he let the dog smell or see a piece of meat. Pavlov concluded that the first reaction is *native* but that the second is *acquired.* In order to test his hypothesis, Pavlov set up a number of carefully controlled experiments in which the dog was isolated from all other stimuli than those the experimenter chose to present. If he rang a bell, there was no change, at first, in the amount of secretion; but if he gave the dog a piece of meat, there was a definite increase in the amount of saliva. Then when he rang the bell and presented food at or near the same time, making use of the law of *contiguous stimulation,* there was a definite increase in the secretion. After a repetition of the combined stimuli ten to twenty times, there was a flow of saliva at the sound of the bell alone. Encouraged by his results with the auditory stimulus, Pavlov performed other experiments in which he succeeded in attaching the salivary reflex to olfactory stimuli, such as the odor of camphor; to tactual stimuli, such as touches or scratches on the skin; and to various others. He concluded, further, that by properly controlling the conditions under which stimuli are presented, the salivary reflex, and possibly other and more complex types of responses, can be attached to any stimulus to which an animal can be induced to react. (5)

Meaning of Other Terms

Pavlov called the new reactions he had discovered and established *conditioned reflexes.* He called the food stimulus a *native* or *original* stimulus (in the terminology of others, the biologically adequate stimulus); the new stimulus he called an *unconditioned stimulus;* the process of learning he designated as *conditioning.* In experimenting with a still greater variety of stimuli, Pavlov found that one stimulus could be substituted for another. For example, the bell stimulus may cease to elicit the salivary reflex in favor of a scratch on the leg, when these two are combined. In this case, the scratch on the leg becomes a *substitute stimulus.* Moreover, when the animal ceases to respond to being stuck with a pin by scratching the place, and secretes saliva instead, we have a *substitute response.* (10)

The complete work of Pavlov not only resulted in adding all these terms to psychological thought, but it also resulted in

much clearer understanding of habit formation on the lower levels. As one can see, conditioning as described above involves learning considerably below the intellectual level.

Neural Processes Involved in Conditioning

New Connections

The connections formed by the conditioning process may be illustrated as follows:

A. Before Repetition

S_1 Original, food, tastebuds ·················· R_1 Saliva, native
S_2 Original, bell, ear ························· R_2 Pricking up ears, native

B. After Repetition

S_1 Original, food, tastebuds ·················· R_1 Saliva, native
S_2 Conditioned, bell, ear ······················ R_1
Original, ear ····························· R_2 Pricking up ears

Before repetition, as in A, S_1 and S_2 lead to different responses, both being native or original stimuli for flow of saliva and pricking up ears respectively. After being presented at or near the same time and often enough, the sound of the bell becomes an effective stimulus for the salivary reflex. From this it is apparent that a new connection has been made between S_2 and R_1, and probably one has been made between S_1 and R_2. Structurally, the receptors in the ear are connected with the salivary gland. The connection consists of a group of synapses between the afferent and efferent neurons connecting the receptors and reactors involved in the two reactions. (11)

Neural Pathways

Let us study the processes by which these new connections are formed. Pure or native reflexes, it will be recalled, involve connections mainly in the spinal cord and midbrain, which function independently of the cerebral cortex. When a new stimulus is introduced, however, an afferent or sensory impulse is initiated which has no ready-made connection by which it finds a motor outlet. This impulse goes, therefore, to the cerebral cortex, first to the appropriate brain center, and then from there to the reflex center in the medulla or spinal cord. From here it is relayed by connecting neurons to the motor neurons which carry it to the reactor. The impulse initiated by the new

stimulus thus appears to converge and to join with the impulse initiated by the original stimulus in the reflex centers. No one knows why such convergence takes place, unless there is some kind of attraction between impulses that are initiated at the same time. At any rate, the convergence takes place, and the

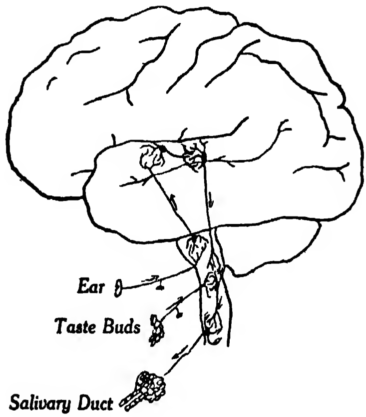

FIG. 28. Simplified illustration of the nerve connections that are probably established in conditioning. Native connections are shown in the lower levels; acquired connections are illustrated in the upper levels.

new connections formed in the reflex center cause the new impulse to find its way out over the same neural pathway used by the impulse initiated by an original stimulus. Thus, the same response takes place to each of the stimuli.

Since the new connections formed for the impulses initiated by the new stimulus presumably involve a pathway through the cerebral cortex, the conditioned reflex is a much more complex type of behavior than is the original reflex. The new reaction, in fact, nearly always involves some amount of conscious behavior, such as sensing the qualities of the stimulus and learning to recognize or perceive it. This is especially true in the case of human subjects. Moreover, any interference with the cortical centers or with the afferent nerves leading to the cortex should interfere with or block the conditioned response. That this occurs has been demonstrated by cutting the afferent nerves leading to the cortex after a conditioned response was established. Furthermore, the conditioned response disappears if the connections involved in the original reflexes are destroyed or

prevented from functioning. The explanation for this is as follows: Nerve impulses initiated by the original stimulus have ready-made conduction paths by which they find an immediate outlet to the reactors. Nerve impulses initiated by new stimuli, on the other hand, have no such outlet. They seek one and find the one that happens to be functioning at the time the outlet is needed. In doing so, the converging of the two groups of impulses takes place, and a new neural pathway is opened up in the reflex center that is used by each group. Thus, any interference with this center will interfere with the conditioned reaction. (10)

Methods of Conditioning

Order of Presentation

It should be apparent from the descriptions of Pavlov's experiments that conditioning goes on in accordance with the *law of contiguous stimulation.* That is, if a new stimulus is to be attached to a given response, it must be presented at or near the same time the original or normal stimulus is presented. Pavlov was interested not only in attaching new stimuli to the salivary reflex but also in determining the order of presentation and the maximum amount of time that could elapse between the stimuli for the conditioning still to take place. In order to study this problem, he tried to present an original stimulus first and the new stimulus a few seconds later. This method failed every time to result in establishing the desired connection. He found, however, that the new stimulus would attach to the reflex when presented simultaneously with and at various intervals before the original stimulus. The following variations in presentation were each found successful: (1) Simultaneous presentation, presenting the two stimuli at the same time; (2) Successive stimulation, (a) presenting the new stimulus first and the original stimulus immediately after or a few seconds later; (b) presenting the new stimulus first and the original stimulus an appreciable time, as much as several minutes, later. (5, 10)

Effects of Intervals between Stimuli

When the two stimuli are presented simultaneously, a connection is formed after ten to twenty trials. When a few seconds elapse before the presentation of the original stimulus, from

twenty to thirty trials are necessary. Under some conditions, the connections are formed when the interval of time is from one to thirty minutes. These connections are, of course, more difficult to establish than when one of the first two methods is followed. It has been found, however, that if an interval of time elapses between the stimuli, the conditioned reflex may occur that amount of time behind the new stimulus. For example, if the bell is rung and food is presented three seconds later, the conditioned reflex, after repetition, will occur each time three seconds after the bell is rung without the original stimulus. The animal is thus conditioned to the interval of time as well as to the new stimulus. These *trace reflexes*, as such reactions are called, have been established even when the separation of the new from the original stimulus has been by a time interval of as much as thirty minutes. These are called "trace reflexes" because the conditioning appears to be due to traces or effects in the nervous structures left over from the new stimulus. (5, 10)

Experimental Studies of Conditioning Children

After Pavlov's success in conditioning the salivary reflex of the dog, many investigators, particularly in Russia and America, undertook experiments designed to study this type of learning in human beings. Since children are unable to introspect or react subjectively, little if at all better than animals, the method of conditioning seems to be well suited to the study of their learning and behavior.

Conditioning Reflexes

Krasnogorski, a student of Pavlov, was the first to study conditioning in children. By using methods similar to those of his teacher, he succeeded in conditioning the salivary reflex in children to such stimuli as the sight of food, a bell, a musical note, and a slight scratch on the skin. In America, Lashley, working with a child, succeeded in establishing the salivary secretion when a bar of chocolate was held in the hand or against the lips of the subject. After devising a method of measuring the amount of the secretion, Lashley tested the effects of different stimuli on the amount. He found that the amount of saliva increased when the child tasted or smelled

the chocolate in the hand of the experimenter. Then he let the child hold the bar, touch it to the lips, smell of it, and taste it contiguously a number of times. Afterward, he noted that holding the bar or touching the lips without smelling or tasting it increased the amount of the secretion. The reflex was thus conditioned to the tactual stimuli. (5)

Another investigator, Miss Mateer, worked with more than fifty normal children from one to six years of age, and with six feeble-minded children. Her problem was to determine the relative ease with which the two types of children were conditioned and the length of time they retained the new connections. She proceeded in somewhat the following manner: Each child was asked to lie on a couch. After he had quieted down, a bandage over the eyes was applied, and the right arm, above the elbow, was stimulated with a soft brush for ten seconds. At the end of this time the brush was removed, and the child was fed a bit of sweet chocolate or sweetened water. Repetition of the procedure, she says, resulted in the conditioning of the salivary reflex to the brush stimulus and also to the bandaging of the eyes. After several repetitions, the children began to show expectation of the chocolate and to secrete saliva as soon as the bandage was applied, without being stimulated with the brush.

A summary of Miss Mateer's results seems to show that (a) bright children are more easily and more quickly conditioned than are dull children; (b) children who excel in grip and lung capacity learn faster than others; (c) children who learn fastest retain the reflex longest; (d) girls retain the reflex longer than do boys; (e) feeble-minded children are more difficult to condition and uncondition than are normal children; and (f) the number of trials needed for unconditioning decreases as age increases and as the trials needed for learning increase. In order to uncondition the reflex, Miss Mateer stimulated the children with the bandage and brush a number of times and withheld the chocolate. Children below thirty months of age were found to be very difficult to uncondition; older children were relatively easy to uncondition. (3, 5, 10, 13)

Conditioning Muscular Reflexes and Instincts

The possibility of attaching muscular reflexes and complex instinctive acts to new stimuli has been demonstrated by a

number of additional experiments. We shall mention some of the results without attempting to describe the experiments. One investigator found that mouth-opening and swallowing movements in infants can be conditioned to a bell and to the tickling of various parts of the body with a soft brush. Another experimenter trained a child six years old to secrete saliva and open its mouth when a metronome was beating at the specific rate of 144 beats per minute; and he trained the child not to respond to the metronome when beating at the rate of 92 and 120 beats per minute. This experiment shows how specific such responses are. Another investigator trained children to make rhythmical sucking movements when placed in certain positions or postures. Here the responses were to massive contact and kinaesthetic stimulation rather than to visual, auditory, or olfactory stimuli. (3)

Conditioning Emotional Responses

Conditioning and unconditioning emotional responses may be illustrated by referring to the work of John B. Watson with emotional reactions of children.

Direct Conditioning. By working with a child eleven months old, Watson succeeded in attaching the fear response in the child to a rat. He proceeded as follows: (a) He presented the child with a white rat with which it had been playing for weeks. The child reached for the rat with the left hand. Just as he touched the animal, the child was frightened by a loud noise produced by striking an iron bar just back of his head. The child jumped violently and fell forward on the mattress but without crying. (b) One week later the rat was presented suddenly without a loud noise. The child gazed at it but did not reach for it. The animal was then placed nearer and it began to nose the child's hand. The child showed a strong tendency to avoid playing with the rat. (c) The combined stimulation with the rat and the noise was then repeated seven times. Then the rat was presented alone. This time the baby began to cry, fell over, and crawled away as rapidly as he could. The fear response was thus attached to a new stimulus which at the beginning brought out the play response. A formula worked out to illustrate the process is as follows:

A. BEFORE REPETITION

S_1 loud noise.................. R_1 fear
S_2 rat......................... R_2 play

B. COMBINED STIMULATION

S_1 and S_2....................... R_1

C. AFTER SEVEN REPETITIONS

S_2............................ R_1

INDIRECT CONDITIONING. The infant now conditioned to fear a rat at sight had, before the experiment, been playing with rabbits, a fur muff, the hair on the attendant's head, and false faces. After the experiment a test was made to determine whether any transfer would take place. A rabbit was presented first, and the infant showed a decided negative response of fear and withdrawal. A fur coat was presented next with the same result. Cotton wool presented in a paper package elicited a negative but less violent fear response than the other objects. The attendant's hair brought out a strong negative response. This test after direct conditioning illustrates the principle of *indirect conditioning*. It implies that if an individual, particularly a young child, is conditioned to respond positively or negatively to a given stimulus, he is likely to exhibit the same type of response when confronted with similar objects. Indirect conditioning is thus a type of transfer of training. It is obvious, perhaps, that indirect conditioning takes place most readily when there is the highest degree of similarity between the conditioned and other stimuli. In other words, training transfers in the greatest amount when the situations to which the individual reacts are similar.

UNCONDITIONING. After a conditioned response is established, is it possible, directly or indirectly, to eliminate the connection? The results of Miss Mateer's study, noted above, indicate that disuse and failure to supply the original stimulus will result in the loss of the connection. Watson found that by following a careful procedure he could eliminate the fear of a child for a rabbit. His procedure was somewhat as follows: (a) He seated the child who was afraid of a rabbit at a small table in a large room and served him his lunch. (b) Just as the child started eating his lunch, the rabbit was displayed at a distance in a

wire cage. The child stopped eating and started to get down out of the chair. He was urged not to get down but to continue his meal. (c) The child continued eating and the rabbit was left in the cage far enough away not to disturb the eating. (d) The next day at lunch the rabbit was brought closer until disturbance was barely noticed and left until the meal was finished. (e) The third day and succeeding days a similar routine was followed, until finally the rabbit could be placed on the table, then in the child's lap. Tolerance had changed to positive reaction, so that the child would eat with one hand and play with the rabbit with the other.

By testing the child after this *unconditioning*, Watson found that he showed less fear of other objects similar to the rabbit, to which he had previously shown considerable fear. This finding indicates, of course, that indirect unconditioning will take place the same as indirect conditioning, and will transfer in a similar manner.

The chief factor in Watson's procedure in unconditioning, it seems, was that of controlling the situation so that the fear response was not allowed to take place. Had the child been permitted to become afraid while in the large room at his lunch, the fear response would perhaps have become attached to the room, to the kind of food served, to the chair, or to some other part of the total situation. Another important factor in the procedure was that of introducing the fear-educing stimulus (rabbit) at a time when the child was experiencing an opposite type of affective state (pleasurable feelings occasioned by food). If the rabbit had been introduced when the child was in other than a pleasurable mood, the chances are it would have frightened him in spite of efforts to the contrary. (5, 15)

Summary of Principles of Learning Disclosed by Experimental Studies of Conditioning

The experimental studies of conditioning just described, illustrate and substantiate the laws of learning stated in the previous chapter. Let us review these principles in the light of the methods and procedures employed in conditioning. Such a review will furnish a number of suggestions for controlling the behavior of young children.

(1) If a new stimulus is presented at or near the same time an

original stimulus is presented, a connection tends to form between the new stimulus and the old response. (*First part of the law of contiguous stimulation.*)

(2) Repetition of the stimulation and reaction strengthens the connection between the new stimulus and the response. (*Law of use.*)

(3) If the original stimulus precedes the new stimulus, no connection is formed. (Pavlov's finding.)

(4) Simultaneous stimulation results in forming connections more quickly than does successive stimulation.

(5) If an interval of time elapses between two stimuli, the conditioned response occurs that amount of time from the conditioned stimulus. (Trace reflexes and responses.)

(6) The vigor or strength of a conditioned response is proportional to the strength of the original stimulus. (Lashley's experiment.)

(7) If a new stimulus is applied several times in succession without being accompanied by an original stimulus, the strength of the connection between the stimulus and the original response rapidly decreases and soon ceases to function. (Mateer's study.)

(8) If a conditioned reaction is not exercised for a considerable period of time, the strength of the connection is impaired so that it may cease to function. Though weakened by disuse, these new connections are not eradicated. They can be brought back to their original strength in a much shorter time and with less repetition than is required for the original. (13)

CO-ORDINATION

Description

As indicated above, *co-ordination* is essentially the organization of separate muscular responses into harmonious patterns to meet the requirements of varying situations. It is a type of learning involved, therefore, in the modification of inherited patterns, such as walking, running, jumping, and expressions of emotions, and in the acquisition of such simple skills as swimming, riding a tricycle, and manipulating various objects. In perfecting and acquiring such patterns as these, the learner is doing considerably more than attaching ready-made responses

to specific stimuli; he is modifying ready-made patterns, acquiring new responses, and making combinations of separate movements, whether inherited or acquired. This is accomplished mainly by regulating the sequence and intensity of action of separate muscles so that they will work together smoothly and somewhat rhythmically.

Examples of Co-ordination

How such learning occurs may be illustrated by studying the ways in which various types of inherited functions are made over and organized into skillful acts, and by noting the ways in which new activities are acquired. Examples may be taken from locomotion, vocalization, manipulation, and the like.

Locomotion

Such instinctive acts as walking, running, jumping, skipping, and other gross bodily movements are modified by learning. In running, for instance, the young child learns to maintain balance under varying conditions and at different speeds, to avoid stumbling over objects, to start and stop and to accelerate and retard speed, to follow a moving object, and the like. In learning to do these things there is little conscious effort to direct the various movements, but there is a gradual improvement in the total performance. At first, the acts are clumsy, random efforts in which particular muscles move in the wrong direction or fail to move at all, and in which there is considerable inhibition that appears to occur because of opposite responses tending to go into action at the same time. Gradually, however, after much practice, the separate movements begin to work together in a pattern of performance that functions smoothly and rhythmically in a wide variety of situations.

Vocalization

The sounds made by very young children only faintly resemble those made by growing children and adults. Equipped with certain elementary sounds, however, the child begins to combine them into new patterns that gradually come to resemble those of the language forms used by persons around him. The process of combining inherited sounds seem to begin during the first days of life. During this stage, at least, the infant has

been observed to make such vowel sounds as "a," "u," "e," "oo" and "ä," and such consonant sounds as "m" with "a," "n" as in "not," "g" as in "got," "h" as in "hat," "r" as in "rat," "r" as in "burr," and "y" as in "yawl." By the end of the fourth month, the normal infant can make a sufficient number of sounds to utter almost any word. Real language forms do not appear, however, until about the beginning of the first year, when the child begins to "babble" or to produce sounds that resemble phrases and sentences. After the "babbling stage," as this period has been called, the child begins to enunciate particular words with some degree of accuracy; clearly enough, at least, to be understood. Then comes a final stage during which the child combines words into short phrases and sentences and finally into questions and exclamations. During this stage there is also a perfection of such elements of speech as inflection, intensity, and enunciation of various syllables. By the end of the third year, the child can utter almost any language sound that he may be urged to attempt, particularly if the sound stimulus is repeated again and again and his efforts follow immediately upon the presentation of the stimulus. (1, 7, 9)

Manipulation

A development similar to that in locomotion and vocalization takes place in various forms of manipulation. At first, as we have seen, the child manipulates objects by picking them up and throwing them down, in a very clumsy fashion. Gradually, however, he holds objects and turns them about, picking, pulling, and pushing at different parts of them. Then he begins to make clumsy efforts to handle them in ways he observes others use them. That is, instead of trying to pull them apart, he begins to use them or make them perform in various ways or combine them in different forms, such as piling or stacking different objects together to "make" things. In all of this, there is a gradual improvement taking place in the degree of skill with which various objects are manipulated, yet, perfection is never attained until the period of adolescence and thereafter. The development that goes on is in the direction of an increasing use of the small or fine muscles. That is, during the early stages of manipulation, the child handles objects only in ways that will involve

the large muscles of the hand, arm, and shoulders; but in later stages, he manipulates things that will involve the finer muscles of the fingers and fine adjustments of the coarser muscles.

Acquired Skills

The growing child not only makes over inherited forms of behavior, but he also acquires many new patterns that have few inherited bases. Such performances as riding a tricycle, swimming, playing various games, and dressing oneself seem to be of this character. In these the child is confronted with tasks that involve a high degree of skill. If not too complicated, the young child makes adjustments that exhibit fairly perfect co-operation among the various muscles. The improvement is in the direction of getting rid of numerous random and useless performances and of organizing particular movements into definite patterns.

In learning to ride a tricycle, for example, the young child usually gets on the seat and begins to move his body back and forth in an effort to move the conveyance forward. Since this will not produce the movement, he may try moving his feet and legs. In doing so, he makes contact with the pedals and chances to move forward or backward. Then he works at the task of following up the discovery, using his feet and legs to propel his conveyance backward and forward for short distances. In doing so, he runs into objects and this shifts attention to the handle bars, which he may work with his hands in an effort to guide the movement while propelling himself forward. While he is successful in avoiding objects, he gradually acquires the ability to guide and propel the conveyance at the same time. Eventually, he becomes quite expert in mounting, riding wherever he desires, dismounting, and the like. (6, 9)

Processes Involved in Co-ordination

The foregoing examples of co-ordination will help to concentrate attention on various processes involved in this type of learning, which educators should take into consideration in helping to cut down the usual waste involved in such learning. These processes are: (a) various neural and conscious processes, (b) maturation, (c) motivation, (d) trial and error, and (e) repetition, each of which will be discussed.

Neural and Conscious Processes

The neural processes involved in co-ordination are far more complex than those involved in conditioning. This is true, first, because the learner is acted upon by a variety of stimuli at once; and second, because the response is complex and varied. In learning to walk, run, speak, ride, manipulate objects, etc., there is no one stimulus to which the individual adjusts but a variety of stimuli appear simultaneously and also in successive order. The act of walking, for instance, depends upon visual, tactual, static, kinaesthetic, and possibly internal stimulation, and the consequent arousal and transference of nervous energy from one brain center to another and from these latter to the reactors. There is no doubt that a considerable amount of integration goes on by which mental confusion is gradually eliminated and automatic control of the varied responses is affected. Visual sensations help to guide the performance with respect to objects in the pathway of the learner and the direction that the movements take. Tactual sensations possibly arise from the contacts of the skin of the feet against the floor or ground—kinaesthetic and static sensations arise from the movements of the muscles and the varying positions of the head and body. Though a complex mental state, composed of these and other sensations, is present in the initial stages of co-ordination, the process of integration sets in and quickly reduces the amount of confusion usually experienced by the learner. The integration consists of organizing the synapses in the various nerve centers affected, so that the nervous energy is discharged readily into the appropriate motor centers and from these to the particular reactors involved. When this process is completed, the muscles can work together with a minimum of interference or confusion of movements.

The absence of integration in the initial stages of co-ordination results in a large amount of unnecessary diffusion. The various receptors, being acted upon simultaneously, discharge a flood of impulses into the cortex, which has no outlets except previously established pathways. By following these pathways, the impulses arouse a large number of reactors not needed in the adjustment and occasion a large amount of error. This is why the individual attempts to utilize responses acquired in other

situations in adjusting to a present situation. As integration goes on and incoming impulses are routed over particular pathways, the unnecessary diffusion disappears. The final result is the opening up of numerous nerve pathways that offer little resistance to any incoming currents, and the consequent reduction of the amount or degree of consciousness arising in connection with the performance. That is, the pathways may become so deeply established that the activity can go on with a minimum degree of conscious effort or direction. The sensations, feelings of effort, and the high degree of attention and confusion observed in the initial stages all disappear, and the performance is carried on as an automatic or self-directing activity. (4)

Maturation

Maturation, it will be recalled, is the stage in the growth and development of the physical structures involved in a given activity that the individual must reach before he can perform that activity. The process is responsible, as we have seen, for the appearance and operation of various inherited functions appearing at various stages in life after birth.

Not only is maturation responsible for the appearance of instinctive acts, but it also has much to do with learning at various stages. In the first place, the organs of the body must have reached a certain stage of maturity before various forms of behavior can be acquired. It would be almost impossible, for instance, for the child of three to learn how to write legibly. The various elements of the nervous system are not ready for acquiring this form of behavior. In the second place, the degree of maturation limits the rate of progress of co-ordination. The child of seven could not learn to write, for example, as quickly as the child of nine. In the third place, the degree of maturation determines the degree of efficiency attained by individual learners. The average child of eight does not write as well as the child of twelve, when both have been subjected to the same opportunities for learning. In brief, most functions acquired by co-ordination go on in conjunction with the maturation of structures. This is one reason why it is necessary to train in the same function from year to year.

In order to take account of maturation in co-ordination, parents and teachers should exercise care in the selection of tasks

to assign to children, being cautious not to require them to do or learn things they are not structurally ready to undertake. This caution is particularly important with regard to requiring children to carry on various types of work. Muscular activity that requires a high degree of co-ordination, especially of the fingers, is sometimes thought to be injurious. Fortunately, young children are not often required to work but are permitted to spend most of their time at play. Here the children usually choose to engage in activities that they can succeed in acquiring. Too, they are free to progress at a rate suited to their inclinations. For the development of such functions as running, jumping, climbing, and other gross bodily activities, the child needs only space, opportunity, and freedom from restraint. In order to develop manipulative activities, the child should be given a wide variety of objects with which to play, and should be left to do with them whatever he wishes. As a rule, it is possible to select objects the manipulation of which will result in a degree of skill commensurate with the child's stage of maturation. In training speech activities, the child may be coaxed to repeat them. On the whole, we may say that in acquiring skills previous to entering school, the child should in the main be left to his own interests and initiative, though given opportunity to develop many interests and types of performances. (9)

Motivation

Unlike conditioning, co-ordination requires a high degree of motivation or the striving to attain particular ends or goals. When an individual is being conditioned, he is usually, if not at all times, unaware of the end or goal of the learning process, and may be unaware that learning is taking place. Whatever goals there are exist in the mind of the person who presents the stimuli. But in co-ordination, the learner is nearly always striving to satisfy some motive or group of motives, and this effort is largely responsible for whatever learning that takes place.

Motives for learning usually vary according to the following types: (a) the desire, tendency, or inclination to engage in and continue a pleasure-educing type of behavior; (b) desire, craving, or drive, arising from a tissue need; (c) desire or craving for a particular object perceived as the satisfier of an acting tend-

ency; and (d) the tendency or drive to avoid making responses that are annoying.

The first type of motivation is illustrated in the learner's efforts to master the techniques involved in different kinds of play. Play activities are usually motivated by such tendencies as the urge to be bodily active or to get rid of surplus energy or to continue to secure a particular group of pleasant sensations. Here the motive arises from interoceptive stimulation and exists in the form of the general tendency to play. In order to satisfy the tendency, the child needs only to engage in the form of play that he chances to hit upon. That is, play activities are largely motivated automatically, so that the individual continues the performance without feeling impelled to do so. This appears to be the type of motive back of such behavior as running, jumping, hopping, riding a tricycle, and the various forms of manipulative play.

The second type of motivation may be illustrated by hunger, thirst, tendency to get cool when too warm, and other physiological tendencies the satisfaction of which depends upon dealing with particular objects or situations. Here the motive arises from a tissue need and prompts the individual to react vigorously to various situations. Though not frequently used as a means of getting young children to learn, this type of motivation is usually employed to get animals to engage in learning activities. For example, a rat may be starved for several days and then be placed in a complicated maze that the experimenter expects it to learn. Prompted by the hunger drive, the rat engages in numerous exploratory activities and eventually learns to "run" the maze. Young children may be prompted to learn by such drives, but they are not often used for this specific purpose.

The third type of motivation involves the task of confronting the learner with an object that arouses a desire or drive and that is perceived as a satisfier of the urge or drive. For example, children will try to open boxes, climb stairs, dress themselves, and engage in different types of work to secure attractive objects. The urge or drive in this case is combined with the external object which the child tries to attain. The child not only perceives the object as a satisfier of the drive but he also understands that the task at hand must be accomplished in order to attain it. A reward of this type is particularly effective if it

remains within the perceptual field and if the task is not too difficult. Otherwise, the child is likely to cease striving for the object and collapse in grief or give vent to anger.

The tendency to avoid making responses that are annoying is a fourth type of motivation. This of course is a negative type. What the learner acquires is a type of withdrawal activity from given objects or positive activity that will enable him to avoid punishment. Negative motivation is both effective and desirable if it prompts the individual to learn how to avoid dangerous objects, but it is relatively ineffective and undesirable if used in prompting the child to engage in learning positive behavior. That is, the child should rarely ever be scolded or threatened with punishment as a means of getting him to engage in learning things that he is expected to like or enjoy later. (1, 7, 9)

Trial and Error

The most observable characteristic of co-ordination is the trial and error procedure usually adopted by the learner. When he is confronted with a new situation, and strongly motivated to react to it, the learner usually makes a number of blind or random trials or efforts before any degree of success is achieved. Even after he has succeeded in scoring several successes, errors may appear in each successive trial. Gradually, however, through repeated efforts to adjust, errors tend to disappear, and the performance goes on smoothly and easily.

During the course of this trial and error procedure, the parent or teacher may help the child improve by studying the cause of error and indicating it to the child. Frequently, however, it is impossible for the cause of error to be isolated. In this case about all that can be done is to urge the learner to keep trying. Fortunately, even young children can be induced to observe and imitate the performances of others. This procedure may result in the elimination of rather obvious causes of error, but there is no known method by which all errors in co-ordination can be eliminated.

The reasons why trial and error is so characteristic of co-ordination and why errors in performance invariably occur may be stated as follows: (a) The child usually tries to react to a new situation without stopping to analyze it; he seems to depend upon a general impression of the whole situation rather than a

knowledge of its details. In fact, to him the situation is little more than an object standing in the way of satisfying a given urge. Thus, other than the motive there is little left to guide the performance. Even after some progress has been made by hit or miss, the child seems to be guided by various sensations more or less vaguely experienced rather than by insight or knowledge. (b) In the initial stages of learning, there is a considerable amount of diffusion of nervous energy to reactors not needed in the performance. Almost invariably, at least, the child performs numerous superfluous or unnecessary movements. As efforts to adjust increase in number, these superfluous movements tend to drop out. Perhaps the reason for superfluous movements is the appearance of synaptic connections usually employed in adjusting to strange or difficult situations. At any rate, many first efforts exhibit activities usually expressive of emotional states. (c) Trials or efforts are essential to opening up particular neural pathways. This is evident from the fact that the stronger the motive inducing the effort, and the more vigorous the effort, the more rapid the learning and the shorter the period of trial and error that takes place. (4)

Repetition

Another characteristic process that goes on in co-ordination is a large amount of repetition. At first, the repetition is not that of a particular pattern of movements but merely of efforts to adjust. Gradually, as errors drop out, however, repetition is an important factor in strengthening the neural connections and in making them relatively permanent. This is essential, in fact, in all motor performances, whether modified instincts or purely acquired functions.

In order to insure the fixation of a motor pattern by repetition, the learner must have varied opportunities to practice or use it, and he may need constant motivation to make use of the opportunities. Fortunately, most performances acquired by co-ordination are those that are used in everyday life in play and work, so that the problem of securing a sufficient amount of drill is not a serious one. In case a particular performance is not used frequently, and it is desirable to make a permanent habit of it, parents and teachers should remember this need for frequent remotivation and repetition. (2)

The Laws of Learning in Co-ordination

From the foregoing description of factors and processes involved in co-ordination, it is easy to see that the laws of learning are underlying principles. The discussion of maturation and motivation indicates the operation of the *law of readiness* and of *effect*. The discussion of the varied character of the situations to which a learner adjusts is intended to emphasize the *principle of contiguous stimulation*. Remotivation at intervals to insure a sufficient amount of drill suggests the importance of making learning pleasant and successful. This is an application of the *law of effect*. Repetition is emphasized in the suggestion that it is essential in opening up neural connections and in making them strong and permanent. The *law of attention* is involved in that the learner must be attentive to the situation at hand if he is to become able to adjust. Attention in small children is rarely ever directed to details or elements of the situation but to the situation as a whole.

EXERCISES

1. What are the main differences between sensori-motor and perceptual-motor learning; between conditioning and co-ordination?
2. State briefly the character and results of Pavlov's experiments. What new terms resulted from Pavlov's work? Explain each.
3. Show the effects on learning of various orders of presentation and of different intervals between stimuli in conditioning.
4. What types of responses is it possible to acquire by conditioning? Make a list of those that have been studied experimentally.
5. How would you condition a child to overcome its fear of you?
6. Why is it difficult to condition adults to respond in special ways to particular stimuli?
7. Explain the following procedures: (1) direct conditioning, (2) indirect conditioning, and (3) unconditioning.
8. Show how the principles of conditioning disclosed by experimental studies correspond to or differ from the laws of learning.
9. Make a list of specific functions that are acquired by means of co-ordination. How do these differ from the functions acquired by conditioning?
10. Show how it is possible to condition a reaction that has been acquired by co-ordination.
11. Summarize the processes involved in co-ordination. How do they differ from the processes involved in conditioning?
12. What are the different types of motives present in (a) conditioning, and (b) co-ordination?

13. At what stage in co-ordination should successive performances be alike?
14. To what extent is trial and error present in adult learning?

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CHAPTER X

PERCEPTUAL-MOTOR LEARNING: PHYSIOLOGICAL TENDENCIES AND SOCIAL ADJUSTMENTS

INTRODUCTION

Meaning of Perceptual-Motor Learning

Meaning of Separate Terms

The term *motor*, as we already know, describes the movement of any muscle or group of muscles. The term *perception* implies the awareness of stimuli or situations acting upon the receptors in the sense of knowing what they are and what to do to, with, or about them. The act of perception usually ensues directly upon the reception of a stimulus and prepares the individual for a motor response. Thus, *perceptual-motor learning* is the attachment of motor responses to situations that are, at least, partially understood, or that can be perceived.

Contrasted with Sensori-Motor Learning

Perceptual-motor learning is sufficiently similar to sensori-motor to be considered the same by some authors. Both, for instance, are involved in modifying instinctive behavior, and both involve many of the same factors. Nevertheless, the two types differ sufficiently to justify separate treatment. In sensori-motor learning, for example, the learner adjusts to objects and situations without knowing what they are and without stopping to analyze or study them. In perceptual-motor learning, on the other hand, the learner must give considerable attention to both the situations and the reactions that he is called upon to make to them. That is, he must perceive or recognize the nature of the situation in relation to the movements to be made and purposely modify his behavior to conform to the perceived elements. This major difference implies many minor differences between the two types of learning, and these differences will appear in the discussion that follows.

Types of Perceptual-Motor Learning

A study of motor behavior in the adult will reveal two general types: (a) that exhibited in ordinary social situations, by which an individual attempts to satisfy or find expression for various tendencies; and (b) that exhibited in the performance of highly co-ordinated skills. The first type, a bit of reflection will reveal, involves the acquisition of unspecialized patterns of behavior that differ in character from one individual to another; while the second type involves the acquisition of highly specialized patterns that exhibit a high degree of similarity in different individuals. That is, one type of perceptual-motor learning results in the acquisition of the ordinary habits of life; the other results in the formation of particular skills.

Purpose of the Chapter

The purpose of this chapter is to present a discussion of the first type of perceptual-motor learning. The second type will be reserved for a subsequent chapter.

THE PROBLEM OF TENDENCIES

In a previous chapter, considerable attention was given to the characteristics of original tendencies and to the instinctive modes of behavior accompanying them. At this point, attention will be directed to acquired forms of behavior growing out of the different types of tendencies. First, we shall study some general principles governing the operation of tendencies and later call attention to the desirable and undesirable ways in which they are usually expressed.

Role of Tendencies in Behavior and Adjustment

In Behavior

The previous analysis of tendencies should emphasize the fact that most somatic behavior is initiated and sustained by some one or a group of tendencies. Unless shocked into action by some tissue need or by an external stimulus potent enough to arouse an emotion, the individual would remain relatively inert. But being acted upon by such stimuli, and experiencing the tendencies that arise therefrom, the human being is normally an active, striving creature in search of the things that will

satisfy him. The young infant, for instance, is largely inactive until stirred from within by hunger, pain, the desire for bodily activity, or some other urge. At this time, however, the infant becomes vigorously and continuously active until the urge is satisfied or its energies are exhausted. Through the help of the social environment, the infant soon learns what things are required to satisfy many of its tendencies. Thereafter, its behavior is directed toward attaining or securing these particular things. For example, the baby comes to know its mother, to recognize the bottle, or any other object related to the satisfaction of hunger, and as a result acquires definite patterns of behavior toward these things. Thus, anything that satisfies a tendency, whether physiological, emotional, or social, is the thing that an individual, of any age, attaches value to and thereafter strives to secure when the tendency is present. In this manner tendencies represent the motives that prompt individuals to recognize particular objects and situations and to engage in activities perceived as ways of adjusting to them. (10)

In Social Adjustment

The young child, of course, does not know how to satisfy his tendencies. All that he can do is to react to things by using his instinctive equipment, and this is what he does. Every tendency is an impulse that goes immediately into action, without self-effort to restrain or repress either the tendency or the action, irrespective of whether the behavior is adequate or desirable to others. In this respect the young child is an individualist who is willing to conform to the demands and requirements of society, only when he is directed toward the satisfaction of his tendencies.

Because of the child's ignorance and inadequate equipment of behavior, society sets up numerous situations to which he is required to react, and attempts to control his reactions until adjustment is achieved. It has homes, schools, churches, and other institutions for transforming the child into a person able and willing to conform to its requirements. Agents in these institutions, such as parents and teachers, say to the child, in effect: "This object is what you need to satisfy that tendency, and you must stay away from that object. We don't like the way you act when you are hungry, frightened, or angry; and

you must change your mode of action. What you are doing right now may be pleasant, but you must stop this instant; that is not a nice way to act. Here, do this, you will need this mode of behavior when you grow up." In other words, society continually strives to make the child over by direction, restraint, and suppression of particular modes of behavior. That is, society offers the child opportunities to find expression for his tendencies but tries to control the particular patterns of behavior. The problem of the individual is to discover and conform to the demands of society; that of society is to maintain a balance among the individual's reaction tendencies so as to achieve the desires of both. This problem is of unlimited scope and complexity. It is a difficult problem, first, because the individual is complex and modifiable; and second, because society is relatively complex and unwieldy. The individual is not a piece of clay in the potter's hand, however, unless he wants to be; he is rather an active, persistent, living organism that continually strives to satisfy a host of tendencies and drives. Society, on the other hand, is not a mold but a crucible in which these tendencies are either refined and made useful or else fused or alloyed with many vicious elements.

The solution of the problem of social control over the individual depends upon the ingenuity and resourcefulness of educators in finding ways and means of guiding the individual so that he will conform to social requirements without suffering a loss of desirable tendencies. This, as we shall illustrate later, has to be accomplished by directing the process of adjustment and by controlling the environment, and thus giving the individual opportunities to satisfy his tendencies in useful ways. The possibility of solution lies in the modifiability of the individual and in the similarity of different individuals. Individuals are not sufficiently alike to respond to particular stimuli in the same way, but they are sufficiently alike to conform to the same general standards of conduct. Thus, it is possible to secure a high degree of social co-operation between young and old, as that between pupils and teachers, and between individuals who have been trained to conform. In order to accomplish this very desirable result, however, individual tendencies should be modified but not destroyed; sublimated or refined but not eliminated; allowed to find favorable expression but never sup-

pressed or repressed for extended periods of time. The great thing in education, in brief, is to make tendencies allies instead of enemies. (2)

Conflict

Though wise and ingenious, educators will never be able to avoid occasional clashes between themselves and children, or between the aims of society and those of individuals. This is the case for the reason that environment can never be controlled sufficiently to prevent particular tendencies from arising at inappropriate times, and that children are unable to perceive or understand the particular situations to which it is desired that they react. Consequently, there will be clashes, and there will be *conflicts* within the individual.

The term *conflict* has been borrowed from the psycho-analytic school of thinkers, who mean by it "a painful emotional state which results from a tension between opposed and contradictory wishes." When applied to our discussion here, the term refers to an uncomfortable, unhappy state of affairs that occurs when the expression of a tendency is blocked or thwarted, and such a state usually prompts the individual to make an abnormal adjustment. For example, a young child is striving to obtain a desirable object, and is employing a form of behavior, a habit, that has always been successful. The parent interferes with the performance but does nothing to satisfy the tendency. The child is afraid to resist the parent, and is forced, therefore, to give up the object, and even to repress the desire. The result is *conflict.* The child wants the object, but he is afraid to try to get it; he becomes emotional, grieved, angry, or worried; and he broods over his misfortune, possibly for several days. Frequently during this time, he may acquire some peculiar or abnormal type of behavior which will more or less dominate his entire personality. In most instances, however, children do not find conflict so unbearable. They give way to social pressure, weep or get angry, and soon readjust by doing what is required of them. Regardless of conflict, every child's behavior must be made over so that he is able and willing to conform to social requirements; for society, in the main, is too unwieldy to be modified by the individual who rebels against its restraints. (4)

TRAINING EMOTIONAL BEHAVIOR

The Responsibility of the Home

Importance of Early Training

The problem of dealing with emotional behavior is one for any social institution, but particularly for the home and school. The home has the heavier responsibility. This is because the earlier years of life make up the most crucial period in the development of permanent social habits. Parents and guardians should be brought to realize that what happens to the child in the home, the situations or things generally in the environment in which he lives, makes or mars his emotional life. This is why investigations of problem children in school so often reveal abnormal or undesirable conditions in the home. Probably 80 per cent of the serious discipline cases in school can be traced to improper control of the children's emotional behavior in the home. (8)

The Typical Attitude of Parents

Parents usually want their children to feel as they do about things, and they want the children to enjoy themselves to the utmost. For this reason, parents often do their best to force the children's behavior into the patterns they mold for them. If they fail in this, parents give way to children and permit them to satisfy their wants in ways that may not be tolerated by a larger social unit, such as the school. In other words, instead of modifying the emotional behavior of children, parents are themselves modified. At any rate, the children learn their first lessons in the home in their efforts to adjust to conditions there, and carry their patterns of adjustment to the school. Thus, parents should consider from time to time what feelings and emotions dominate their children and whether these lead to modes of behavior that will be helpful or detrimental to the children when they start to school. (8)

Undesirable Emotional Behavior in School

For Which Parents Are Responsible

The experiences which the child has in the home, when surrounded by proper influences, result in a wealth of valuable

likes, dislikes, desires, attitudes, habits, and the like, which the school can encourage and build upon. If surrounded by the wrong kind of influences, however, the child brings to school a stock of behavior patterns that have to be modified or completely disintegrated. How this happens too often in the home may be indicated.

EMOTIONAL OUTBURSTS. Many failures of parents are due to the tendency in the small child to exhibit strong emotional outbursts. At one moment, for example, the child is supremely happy at play, and everything seems to be pleasant; at the next, he is screaming from pain; at the next, he is furious with rage and biting an offending playmate; at the next, he is in a "temper tantrum," kicking, pushing, biting, and scratching because he is denied a want; at the next, he is weeping bitterly or sobbing violently because he is denied a privilege. All of these may occur in the course of a day in the life of almost any normal child. What do the parents do about them? The difficulty with most parents is that they take these outbursts too seriously and allow them to affect their own behavior. The over-anxious mother runs to the child to calm him, and often bestows upon him a shower of caresses and other rewards. This behavior on the part of the mother tends to stimulate and encourage the child to act in this way every time he is provoked. They also suggest to the child a weapon with which to control the mother and get what he wants. Any time the child gets what he wants by indulging in a particular form of behavior, that form of behavior is for him effective, and he will continue to indulge in it, whether it is good or bad from the standpoint of others. Certainly parents should not attempt to suppress emotional outbursts, but they should ignore them or induce the child to exercise control over them. Failure of parents to deal wisely with their children in these forms of expression will work considerable hardship later. Outbursts will not be tolerated by the school, and they are likely to be severely condemned by society at large. Yet, many parents send their children to school with little training in the control of such expressions.

PAMPERING. Many parents pamper and pet their children by supplying too many of their wants. Some parents go to great trouble and hardship themselves to make life more pleasant for

their children than they have known it. They surround their children with every pleasure-inducing object they can afford. The children get what they want when they want it without giving up anything and without having to work or assume any responsibility. Thus children are permitted to follow their own inclinations and to share the products of the suffering and hardships of others. They do not learn the lesson taught by deprivation and hardship. As a result, they come to school with many unsocial modes of behavior. Such children expect teachers and other pupils to cater to their wishes as do the parents. They are often thankless for any courtesies or privileges, and they usually complain when they are expected to contribute to social enterprizes fostered by the school. They often try to avoid the preparation of difficult assignments.

When confronted with such children, the teacher is obliged to undo much the parents have done and to supply the special types of stimulations the children have not had. She has to tolerate their whims until these are cured, and then set them about the task of modifying their unsocial attitudes. She has to take special pains to show the children the importance and dignity, as well as the profit and pleasure, derived from co-operative work. She may even need to supply tasks that involve a certain amount of hardship and deprivation. She will have to do much talking to help such children understand the nature of the social life represented by the school planned to prepare them for a broader life. All of these special tasks originate, of course, because of improper training in the home.

These are only a few of the undesirable modes of behavior due to improper training in the home. They represent, however, a type of difficulty that every teacher should expect to meet and cope with. In dealing with such difficulties, the teacher should realize the importance of co-ordinating the purposes and activities of the school with those of the home. When these purposes as well as methods of dealing with children conflict, the teacher should make an effort to indicate to the parents the causes of their child's difficulties and enlist their aid in overcoming them. Parents, in the main, will co-operate when they discover the trend of events in the life of the child and realize that his difficulties are frequently due to their own shortcomings. (5, 8)

For Which Teachers Are Responsible

Because of the effects of home influence and training, it is difficult to estimate the undesirable emotional traits in children due to the teachers' influence. As bad as it may appear, however, teachers are often responsible for the cultivation of numerous unfavorable or antagonistic attitudes, toward themselves and school in general, as well as toward the ideals and purposes and work of the school; for various disciplinary problems; and for different special modes of behavior due to emotional nature exhibited in every child. These may appear as a result of the teachers' failure (a) to understand the nature of emotional reactions and how to deal with them, (b) to take into account individual differences in emotionality, (c) to understand special modes of behavior that appear and how to deal with them, and (d) to employ types of stimulation, or motives, that will make school work interesting and absorbing. All of these failures may be traced, in turn, to the lack of available information regarding the emotional aspects of human nature. Let us notice at this point the general status of this problem.

Status of Emotional Control

In the Past

In the past, and possibly to a large extent at the present, educators have been concerned chiefly with the education and training of intellectual processes, such as memory, imagination, and reasoning. Because of their disturbing character, emotions and emotional tendencies were believed to be of a lower order of mental processes and not worthy of serious consideration. As a result, little attention has been given to emotional training. For much the same reason, and because of numerous difficulties encountered in studying them scientifically, psychologists, likewise, have neglected the study of emotional reactions. In general, psychologists have stressed emotions as mental disturbances which interfere with intellectual processes, and have emphasized the value of self-control. Thus, in school, emotional reactions have been looked upon as undesirable; and the excessively emotional child has been thought of as a kind of nuisance. This child has even been described as wayward and sinful, or contrary and unmanageable, and thus a subject of

the strictest discipline. The task of the teacher, from this point of view, is mainly that of developing the purely intellectual processes and of forcing children to repress all emotional behavior. Many teachers believed that their chief work was that of confronting the child with a strong switch and an endless array of difficult and unattractive tasks. Consequently, emotional behavior has often been punished or suppressed, with the result that children, in numerous instances, have developed traits and modes of behavior of the most undesirable types.

At the Present Time

In recent years, tendencies and emotions have been the object of much study and research by both psychologists and educators. Psychologists are working at the task of understanding their nature and values in relation to other physical and mental processes; and educators are trying to find methods that may be applied to the training of emotions in the same way that methods are applied to the development of intellectual processes. Thus the narrow intellectual view is giving way to the view that stresses the education and training of the *whole child.* The view that emotions are detrimental is giving way to the conviction that they are helpful and beneficial if only they can be directed and modified to suit the variable, changing requirements of society. At the present time, perhaps, teachers are realizing more than ever that emotional reactions are a significant part of the raw material which it is the function of the school to work over and make valuable to the individual as a worthy member of society. Now restrained from using corporal punishment for the suppression of emotional outbursts, teachers are asking many difficult questions as to how to deal with emotional behavior. They are at least aware of the problem and are trying to find information that will help solve it. (2)

Helps to Be Suggested Here

There is still much to be done toward understanding emotional behavior, but we shall try to indicate some of the forms of behavior that grow out of emotional tendencies and to suggest how the teacher should deal with them. Our discussion will be concerned chiefly with those patterns mentioned above, for which the teacher is often responsible.

Individual Differences in Emotionality

The problem of assisting individuals in adjusting to various aspects of school work depends, to some extent, upon their degree of emotionality. In a previous chapter attention was called to differences among individuals in this trait and to some of the methods used in measuring it. Here we may notice the manner in which persons of different degrees of emotionality react to different situations.

The Unemotional

The unemotional person is not one who is incapable of responding to emotional stimuli but one who is relatively difficult to arouse. He usually ranks low on an emotional questionnaire or rating scale, and he may be expected to remain more or less calm, stolid, and unperturbed in the most exciting situations. He receives unexpected news that would excite other persons, for example, without getting excited; and he is rarely moved when others are alarmed. This individual usually gets along well in life, provided he has normal intelligence or above, even though he may be somewhat difficult to arouse to high points of interest. He is rarely ever a problem case.

Normal Emotionality

The normally emotional person does the usual or expected thing in emotional situations. This degree of emotionality is ordinarily assumed in the average teaching situation. Most children respond enthusiastically to suggestions made by the teacher without creating special problems.

Excessive Emotionality

The excessively emotional person is one who is easily aroused and whose emotional reactions are relatively intense. His joy runs to ecstasy, his fear to horror, his anger to rage, and so on. The most distressing thing about him is that he becomes emotional when there is little or no occasion for doing so. His "feelings" are easily hurt, and he is frequently gushing tears. This person rates high on an emotional rating scale or questionnaire.

Emotional Instability

Excessive emotionality is frequently associated with emotional instability. This condition exists in individuals who are unable to tolerate the tasks, hardships, and restraints ordinarily met with and tolerated by others. When requested to work alongside of others in school, the emotionally unstable child, even though he may be equal to others in ability, often "goes to pieces." He cannot take tests and examinations nor hold himself down to tedious or monotonous work for long periods of time without suffering undue fatigue and boredom; and he is practically "undone" when expected to do rapid, exciting, exacting, or dangerous tasks. Such children are often "problem cases," because they are fractious in their responses to criticism, blame, or rebuke.

In dealing with such persons in school, it is wise to let them follow their own interests, to a large extent, or else to provide short practice periods for essential drill work. Whatever the provision, it should enable the child to work without the feeling that he is being pressed for time or exactness. Teachers must be very careful of the type of criticism offered, especially when they correct or rebuke the child for unsocial behavior.

Frequently emotional instability is due to extreme nervousness brought about by physical disorders. Indigestion, intestinal disorders, disturbances of heart action, lack of sleep, fatigue due to overwork, and general weakness are some of its causes in otherwise normal persons. Thus one of the first needs of an individual who exhibits this trait is proper medical attention. Nevertheless, many persons who prove to be physically sound are emotionally unsound. In these cases, the condition seems to be an inherited trait, probably based on a hypersensitive sympathetic nervous system. (4)

FORMS OF ADJUSTMENT DUE TO EMOTIONAL STATES

By "forms of adjustment due to emotional states" is meant various patterns of behavior individuals are prompted to acquire, by emotional tendencies, when they are stimulated in different ways by external conditions. These patterns are in addition to the visceral and somatic activities resulting from emotional stimulation. They are, indeed, special ways of feeling

and acting that are left-over effects of emotional reactions. For want of a better term with which to designate all such forms of adjustment, we may refer to them as *emotional habits*. The patterns with which we shall be concerned here are known as attitudes, moods, and complexes.

Attitudes

Meaning

An *attitude* may be defined as an affective state which predisposes an individual to react to a given stimulus in a characteristic manner. The affective state, moreover, consists of a kind of residue from strong feelings or emotions that have been experienced in connection with the stimulus. The stimulus does not now call out the feelings and emotions, but there is a tendency for it to do so; and this tendency is experienced as a physiological and mental "set" or *attitude*.

How Attitudes Are Recognized

An attitude is recognized in persons by expressions of acceptance or rejection of a stimulus; that is, by the behavior resulting from it. If the stimulus is an object or person that tends to arouse affection, the individual is talkative, friendly, or sociable; or he usually tries to get near the beloved object to pat, fondle, or caress it. If the stimulus tends to arouse anger, on the other hand, the individual exhibits an opposite type of behavior; he is unfriendly, unsociable, resentful, irritable, or sullen. These adjectives that describe how a person acts or regards a particular thing are likewise descriptions of his attitudes. Other attitudes are described or suggested by such terms as the following: generous, tolerant, critical, self-conscious, reckless, co-operative, reserved, appreciative, conscientious, selfish, touchy, domineering, obstinate, optimistic, courageous, short-sighted, etc. Such traits as these, it may be observed, make up the characteristics by which our friends understand and judge us. (10)

How Attitudes Arise

Attitudes usually arise in individuals as a result of their efforts to satisfy particular tendencies. If the individual is

assisted in finding, or by chance comes upon, an object that satisfies a strong tendency, his future reactions to that object will be positive. That is, he will seek, pursue, secure, and try to keep that object each time the tendency arises. The pleasure derived from satisfying the tendency eventually attaches to the object; so that the individual will react favorably toward it whether the tendency is present or absent. In this case the person has developed a *positive* attitude toward the object. On the other hand, if an object fails to satisfy a tendency, or annoys or calls out strong feelings or emotions each time it is presented, the individual may develop a *negative* attitude toward it. The positive attitude will then prompt the individual to exhibit a friendly, sociable, or acceptance type of behavior; while the negative attitude will prompt the individual to exhibit an opposite type of behavior. That is, the type of attitude one develops determines how he deals with a particular object each time he comes in contact with it.

Thus it is clear that attitudes are the final products of feelings and emotions experienced in connection with given things. They develop through years of slow and often times unnoticed learning, and undergo changes according to the emotional reactions occasioned by their stimuli. One may admire a given individual for a long period of time, as a result of pleasant relationships, but if he is made angry repeatedly by the friend, his attitude of admiration may be changed to marked unfriendliness or thorough dislike. He may even become critical, domineering, obstinate, or spiteful toward his former friend. Young children are very quick to develop attitudes and quick to change them; but older persons remain relatively unchanged from year to year, except in particular instances. The child first develops attitudes toward objects and persons that have to do with satisfying his basic tendencies. Later he may attach his feelings and emotions to ideas and concepts of things, and thus become a conservative or a radical, a patriot or an anarchist. (1)

Detection of Hidden Attitudes

The subtle manner in which affective states get attached to particular ideas is vividly illustrated in the results of the so-called *association method* of studying emotions. This method is employed by the Freudians in diagnosing emotional difficul-

ties. One variation of the method consists in giving the patient or subject an "association test," and another method consists in asking questions designed to bring out answers which will reveal the causes of the difficulty. The *association test method* was developed by Jung, who presented his subjects with a list of words, usually one hundred, and asked them to give as quickly as possible the first word or idea that they thought of. The words selected for the test usually referred to a large variety of situations, so that the subject was forced by some word or group of words to recall some unusually pleasant or unpleasant experience. These "critical words," as they are called, were thought to have a tendency to revive the emotional experience and thus to be reacted to in a manner peculiarly different from other words presented along with them. If the word reminded the subject of the previous occurrence of some fear, worry, embarrassment, or other emotional upheaval, for example, his language response would be accompanied by laughter, blushing, hesitating, increased reaction time, or by failure to respond at all. Such reactions, Jung thought, are "complex indicators." They occurred for the reason that the stimulus word had been connected with an original emotional experience caused by some other stimulus. When the word was given as a stimulus, it tended to revive the emotional experience itself and to cause the subject to respond in an abnormal manner. These unusual or abnormal responses were thus indices of the emotional nature of the subject and of his attitudes toward particular things.

A concrete example of the method is Jung's classical experiment in which he detected the guilt of a nurse accused of the theft of a purse. The purse when taken was reported to contain a fifty franc note, one twenty-five franc piece, some centimes, a small silver watch chain, a stencil, and a receipt from Dosenbach's Shoe Shop in Zurich. It was known to have been taken from a clothes closet. The suspicion of the theft was narrowed down to three nurses each of whom was asked to submit to an association test. The test contained certain words related to the purse, critical words, and enough indifferent words to make one hundred in all. The critical words included the name of the owner of the purse, cupboard, door, open, key, yesterday, note, gold, seventy-five, twenty, money, watch, pocketbook, chain, silver, to hide, fur, dark, reddish leather

(color of the stolen purse), centimes, stencil, receipt, and Dosenbach. Each person suspected was asked to respond to each word as quickly as possible by giving the first word or idea that came to mind. As the test was being given, a record was made of each response and of the time between the stimulus and the response (response time, measured in fifths of a second). Later the data secured were analyzed to discover any striking differences among the reactions of the three nurses. The average response time for each subject, designated as A, B, and C, was found to be as follows:

	Response Time		
	A	*B*	*C*
Critical words	16	13	15
Indifferent words	10	11	12
Difference	6	2	3

Notice that A's response time to the indifferent words was less than that of B's and C's, while her response time to the critical words was much more. This fact indicates, of course, that A was probably the one guilty of the theft. In order to check this evidence, Jung found the number of imperfect or unusual responses given by each nurse. An imperfect response was one given haltingly, repeatedly, or with evident emotional upset. The number of such responses given by each of the nurses was as follows:

	Number of Imperfect Responses		
	A	*B*	*C*
Critical words	19	9	12
Indifferent words	10	12	11
Difference	9	3	1

Here A is shown to have given 9 more imperfect responses to the critical than to the indifferent words, while B gave 3 less and C C gave only 1 more. It is evident that A was disturbed when the critical words were presented, and that she tried to hide her guilt but in doing so made it more apparent. At least, on the basis of these data, and other results of the test, Jung concluded that A was the one guilty of the theft. That he was correct in his conclusion was confirmed in a later confession by A.

Though not perfected to the extent that they can be relied upon as infallible guides in the detection of guilt, or other emotional upsets, such tests and experiments indicate the manner in which affective states attach to the various situations in which they are experienced, and the manner in which such states attach by indirect conditioning to words or ideas that represent or refer to emotional stimuli. This being true, it is obvious that such learning is responsible for the appearance of the many special complexes, moods, temperaments, phobias, and the like, some of which will be described later. (3)

Unconscious Attitudes

The fact that our affective states are due to activities and processes mainly of the internal organs accounts for the formation and development of many so-called *unconscious attitudes.* These are attitudes that we possess but of which we are unaware. They include such traits as conceit, selfishness, timidity, unkindliness, prejudice, pride, untruthfulness, dishonesty, self-confidence, self-abasement, fears, worries, anxieties, inhibitions, antipathies, mannerisms, antagonisms, and various egoistic peculiarities. We often see these traits in others and they see them in us, but all of us have a tendency to live from day to day without being aware of ourselves as others see and know us. We are sometimes able, of course, to discover such attitudes by self-observation and introspection, but most of us are inclined to escape the amazing and humiliating revelations of careful self-analysis. Our being unconscious of such traits makes it impossible for any of us to remold or remake his character and personality to any great extent, especially after he has permitted such attitudes to become firmly established.

Unconscious attitudes usually have their origins in the experiences of early life. They appear to be the results of arousing affective states in connection with particular objects, persons, and events. They are conditioned reactions. After attitudes are formed, the individual is predisposed to act in accordance with them. The extent to which this sort of thing goes on has been demonstrated in a number of experiments by Zillig and others. Zillig noticed that her fourth-grade pupils often expressed keen likes and dislikes for each other, and she set about to determine to what extent these likes and dislikes influenced the children's

judgments of each other. She first asked each of the ten-year old girls in her class to write down the names of five playmates liked most and the five disliked most. On the following day, without the children being aware of her intentions, she arrayed the ten most liked and disliked children before the class and asked the other pupils to watch them carry out certain instructions. She said to the class: "I am going to give the children who are placed before you a short exercise in gymnastics. You must give accurate attention like the children who are exercising. Attention. Right arm high. Arm down." The children stood ten seconds with arms raised and then let their arms down. Previously, the teacher had privately instructed the most liked children to raise their left instead of their right arms. Thus all the most liked children did the exercise incorrectly, and all the most disliked children performed the exercise correctly. Immediately after the exercise, Zillig asked the children who had been observing to write down the names of the pupils who had performed the exercise correctly, and those who had performed it incorrectly. To her surprise, she found that a higher percentage of correct responses was ascribed to the most liked children than to the most disliked children. This result came about despite the fact that none of the most liked children performed correctly. This result very likely means that the children who did the observing were unconsciously influenced by a strong favoritism for those liked and a strong prejudice against those disliked.

Through other experiments, Zillig has shown that some mature persons have a decided and strong bias for old literature and a prejudice against the new, and that some teachers are influenced by favoritism and prejudice in grading or marking papers. In grading papers, for example, teachers on the average overlooked 38.7 per cent of the errors made by the best pupils and only 12.3 per cent of the errors made by the poorest pupils. (1)

Since we are unconsciously conditioned to respond to things in particular ways, it may be seen that the problem of directing the behavior and forming the character of children is an exceedingly complex one. In fact, we are more or less powerless in trying to prevent undesirable connections from being formed. The best we can do, it seems, is to surround the child with the

best possible environment in order to avoid improper stimulation, and to watch for the appearance of undesirable patterns of conduct. Once they appear, we can set about to substitute desirable for undesirable connections, following such procedures as that illustrated in Watson's experiments with fear. In the school room the teacher should (a) strive to make all school work as pleasant as possible; (b) use school work as a means of satisfying or finding expressions or outlets for desirable tendencies; (c) make desirable forms of behavior satisfying and undesirable forms annoying; (d) avoid the arousal of undesirable affective states in connection with school work; and (e) arrange situations that will call out conflicting tendencies when undesirable patterns appear.

Moods

Description

A *mood* is a prolonged emotional state during which a person feels particularly cheerful, dejected, angry, fearful, "blue," etc. If a person has had reason to feel happy, as upon the receipt of good news, or if his health or streak of fortune is particularly good, he is subject to cheerful or optimistic moods. During these he feels an almost irrepressible tendency to happiness and its forms of expression. He is easy to please, and is usually full of energy and enthusiasm. Moods which follow fear, anger, and grief are somewhat opposite in character. After intense fright, one may feel "nervous" or "jumpy" for several hours or days. After intense anger, especially if its expression has been stifled or suppressed, a person may go about for several days in an "ugly mood" subject to fits of anger, and sometimes violence, upon the slightest provocation. Moods which follow intense sadness, grief, or disappointment are states of dejection, during which one makes weak responses to stimuli normally responded to with vigor. He feels depressed, "down-and-out," or worthless. (9)

Causes of Moods

Moods, as suggested above, seem to be left-over effects of physiological processes that have occurred in the emotional reactions preceding them. They are probably due to glandular secretions still present in the blood, and to the unbalanced con-

dition of the visceral organs. It is known, for example, that, after intense anger and fear adrenin and thyroxin are present in the blood, and that digestive processes are interfered with for a considerable period of time. It is reasonable to suppose that similar conditions follow other emotions. At any rate, emotional reactions leave behind both mental and physical states that predispose the individual to engage in forms of behavior similar to those associated with the emotion.

Moods in School Children

Unpleasant moods in school children are matters of concern for the teacher. She should, at least, seek some verbal expression from the pupil who probably knows the provoking cause of his mood. In case he does not know, the teacher may usually assume that he is suffering physically from some disorder due to improper diet, lack of exercise, or poor circulation. In case a child knows the cause of his mood, the teacher may help him by attempting to remove it or by assisting him to cultivate a conflicting group of feelings. The best general cure for a mood, such as the blues, worry, anxiety, grief, or other forms of dejection, is vigorous physical or mental exercise of an interesting type. This will serve to dominate consciousness, causing the individual to forget his "troubles" and to "drain off" any glandular secretions that may be in the blood.

Another reason why teachers should be concerned about moods is that they are responsible for many unfavorable attitudes. When an unpleasant mood is present, there is always a chance of its becoming attached to an inoffensive object or person. For example, when an individual is required to solve arithmetic problems during a strong mood, the mood may attach to a certain number, a particular type of problem, to arithmetic in general, or to the teacher, so that subsequently the sufferer is unduly disturbed when in the presence of one of these stimuli. This kind of attachment is most likely to form when the pupil is especially annoyed by the thing that engages his attention. It is this kind of experience that seems to account for many of our aversions, likes, dislikes, fears, disgusts, and the like, for objects and persons towards whom we have no occasion to feel in this way. It is certainly the explanation for many abnormalities found in persons afflicted with insanity. (1, 9)

Temperament

Description

The term *temperament* refers to the disposition of individuals whose behavior is frequently dominated by a particular mood or constellation of moods. Some persons, whom we describe as "high-tempered," throughout their lives become angry upon the slightest provocation. Some appear to be dominated by worries, being constantly alarmed at every impending change in circumstances. These we describe as alarmists or pessimists. Some are easily stimulated to fear, which may dominate behavior. Others are dominated by cheerful moods. Some temperaments appear to be the outcomes of moods, and although often annoying in themselves, the individual has found them to be useful in satisfying his tendencies. A child during a period of physical illness, for example, may find that spasms of anger will bring his mother to him or secure many additional things which he finds pleasant and enjoyable. After he is well, the child may find that spasms of anger are still effective in getting what he wants. If so, he may continue to display such behavior throughout life as a means of controlling the behavior of others. Temperaments are thus a kind of emotional habit that an individual finds useful in adjusting to various aspects of his environment.

Inheritance of Temperament

The tendency to be temperamental appears to be an inherited trait. It is usually found in persons who exhibit a high degree of emotionality and in peoples of different races. Peoples who speak the Romance languages, for example, appear to be dominantly temperamental in certain respects. They are said to be similar in their frequent display of emotions and moods, being easily aroused and quick to "cool off." The Germanic peoples, on the other hand, are somewhat stolid, difficult to arouse, and inclined to control their emotional behavior. These differences, of course, may be due to differences in the types of training given to individuals of these races rather than to inherited characteristics. Temperamental make-up is probably dependent, in part, upon the secretions of the ductless glands, for defection among the glands, as we have seen, may change an individual's entire emotional nature.

Acquired Temperaments

To the extent that temperaments are acquired traits, they have considerable bearing upon the emotional development of the child. It appears that many temperaments appear in children through conscious or unconscious imitation of their parents or others. For example, if a child's mother exhibits a disposition to be frightened by every unusual sound or strange object, the child tends to cultivate a similar disposition. Too, a child surrounded by fretful, worried, pessimistic elders is almost certain to assume similar attitudes toward the things the elders fret and worry about. On the other hand, a child brought up in an environment in which emotional control is exercised, and in which he is made to understand that he is expected to control his own emotional behavior, usually responds in a very satisfactory manner. Thus the temperaments that appear in the growing child are frequently the reflections of those in persons whom he imitates.

Since the teacher is a vital influence in the life of the child, it behooves her to consider the kinds of temperaments that she displays to the pupils from day to day. The problem of removing or breaking up an undesirable temperament will have to be discussed in a later section. Suffice it to say here that it is far wiser to change undesirable temperaments while they are yet moods, and before they have become permanent habits. (9)

Phobias

Meaning and Types

A "phobia" is an ungovernable, unreasonable fear, usually of a harmless object. The victim of a phobia is unable to tolerate the presence of the object feared, and may exhibit extreme effort to get rid of or away from it. Studies of phobias reveal that many otherwise normal persons become more or less frantic in the presence of such animals as rats, mice, dogs, cats, pigs, horses, cows, and such creatures as bugs, beetles, and caterpillars. Many have chronic fears of being alone, crossing a bridge, traveling on trains, becoming insane, burglars, darkness or dark places, disease germs, skeletons, narrow places, sight of blood, fast driving, high places, omens of bad luck (number 13, black cats crossing the road, etc.), sharp things, guns, and

others too numerous to mention. Many persons suffer fears, bordering on inferiority complexes, such as being unable to get or to hold a job, not being able to meet strangers, not being able to talk to the "boss," the teacher, or the professor, not being able to recite or talk in class. This last is probably the most important for the teacher.

How Phobias Arise

Phobias usually appear in an individual as a result of a particular experience in which he was extremely frightened. If a young child experiences extreme fright in a given situation, he will likely show fear, later, of the object or objects to which he was giving attention at the time the emotional reaction occurred. If a child is frightened in the dark, for instance, he will probably be afraid of the dark, regardless of what frightened him. He may even show a negative attitude toward the place where the fright occurred, after light has returned. Nearly every pronounced phobia can be traced to an instance of this kind.

Some phobias, however, may appear in children as a result of what they are told about things. A mother worrying about the safety of her boy, for example, warns him not to climb trees, not to go swimming, not to play ball, etc., lest he get seriously hurt, until the boy is afraid to engage in any of these sports. Often mothers and others threaten children with the "bogy man," policeman, or other character or person unknown to them, and thus rear individuals whose lives are harassed with fears. The child may "grow out" of many of these early fears, when he discovers the harmless character of the things he has been taught to fear; but the chances are that many will cling to him, at least in the form of negative attitudes, as long as he lives. Every such fear is not a phobia, but unless care is taken any one may develop into a phobia.

Methods of Removing Phobias

The best policy to follow with regard to most fears and phobias is not to let them appear in the first place. Parents may avoid developing many in children by refraining from appealing to fears of harmless things as a means of threatening them. They should remember that the policeman, for instance, is one of the child's best friends, and that the dreaded "bogy man" exists

only in imagination. After a phobia is formed, however, it should be removed, if possible. The simplest method of dealing with a phobia is that of keeping the sufferer away from the thing that arouses it. One might keep a person from seeing a mouse or a dog, or from being in the dark alone. This method, of course is ineffective in that it does not remove the phobia; it only prevents the individual from experiencing it. Another way is to get the victim to associate with persons who are not afraid of the object that occasions the phobia. By seeing others handle or play with fearful objects, an individual may gradually overcome his fear of them. A child who is violently afraid of a dog, for example, may overcome his fear if the animal is introduced a number of times into a company of children who exhibit a love for and a desire to play with it. Sometimes fears of harmless animals and of particular persons are overcome by forcing the victim into their presence, but such a procedure is of doubtful value. Whether this method succeeds, however, depends upon whether the victim is violently afraid and whether he is excessively emotional. In either case, the victim would likely grow more fearful or lose all reason. Forcing persons to approach things they fear a great deal involves considerable risk. Perhaps the best way to remove a phobia in an adult is by inducing him to take a rational attitude toward his phobia. That is, show him the possible cause of the phobia, the uselessness of its existence, the attractive features of the thing he fears, and the like. Often an individual can be persuaded to face the facts squarely and to realize that there is nothing real on which his fear is based. After the victim admits all this, efforts should be made to get him to *act* on his new convictions and show that the fear has gone. The main problem is to get the individual to look upon his phobia as an intellectual problem in need of solution; and to indicate to him that he is the one who can solve it. In dealing with children, we should rely mainly on the social method discussed above, or upon direct unconditioning discussed in the previous chapter. (9)

EXERCISES

1. Why is the problem of tendencies important to educators?
2. Describe two or three "problem children" whom you know, whose conduct is apparently the result of unwise guidance on the part of their teachers.

3. Make a list of undesirable modes of behavior you have observed in children, which are probably the results of improper training in the home.
4. For what reasons are many teachers responsible for undesirable patterns of behavior in children?
5. To what extent are educators informed regarding the nature of emotional behavior and how to deal with it?
6. Discuss the following statement: "It is as important for the teacher to know the degree of emotionality of her pupils as it is for her to know the degree of their intelligence."
7. Show why persons possess particular attitudes.
8. Do you think Jung's method of detecting hidden attitudes would be successful in discovering various attitudes in school children? Discuss.
9. What is meant by "mood," "temperament," "phobia," and "complex"?
10. Describe and illustrate the best ways of dealing with moods, temperaments, and phobias.
11. Discuss the following statement: "Parents and teachers should seek to prevent conflicts from occurring in children under their care."
12. Make a list of the attitudes assumed by your professor of which you think he is not conscious.

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CHAPTER XI

PERCEPTUAL-MOTOR LEARNING: SOCIAL TENDENCIES AND ADJUSTMENT

INTRODUCTION

Purpose of the Chapter

In the preceding chapter, attention has been called to the problems involved in modifying and training individuals in the expression and satisfaction of their physiological and emotional tendencies. In this chapter attention will be concentrated upon the problems involved in directing and training individuals in expressing and satisfying their social tendencies. Particular attention will be given the following tendencies: (a) tendency to play; (b) the urge to master; (c) craving for rivalry and social approval; (d) tendency to submit; (e) desire for sympathy; (f) tendency to congregate or gregariousness; and (g) the urge to imitate. In the discussion of each of these, an effort will be made to suggest its nature and origin, development and maturation, social provisions for satisfying it, desirable modifications, and uses as a motive in school work.

THE TENDENCY TO PLAY

Origin and Nature

The tendency to play is a general tendency to engage in typical forms of behavior without specific reference to tissue needs. The forms of behavior do not conform to any particular pattern but vary with numerous factors, such as sex and age, tradition, religion, topography, climate, season, fads and fashions, space or lack of it, companions or lack of companions, and various other factors. While there are no specific tissue needs to which the tendency can be traced, it appears to be due to the healthy condition of bodily cells. In this respect, it resembles closely the physiological tendency to be bodily active. The tendency fails to appear if the individual is suffering from

physical injury, or sickness of any kind, and if he is markedly fatigued from work. Thus play appears to be the means by which individuals of all ages find expression for their surplus energy. For the young child, play is almost the sole form of physical activity; for the adolescent, it is an outlet for energy; for the adult, it is a diversion from social and economic obligations.

In socialized play, various other tendencies are present to motivate different performances, such as the tendencies to congregate, to imitate, to rival, to excel, to secure social approval, to avoid social disapproval, to master difficulties or persons, to submit to a leader or superior, and numerous others. Because it appeals to many different tendencies, play is perhaps the most satisfying or enjoyable form of behavior.

Kinds of Play

The kinds of play individuals engage in vary with a number of factors. Tradition plays a part in the fact that numerous games are handed down from one generation to the next. Some forms of play and a few games are so ancient, in fact, that all traces of their origins have been lost. Nations, races, and peoples of different countries have folk plays peculiar to themselves. Religion has an influence in that some religions taboo certain games for one sex or the other, or both sexes, or prohibit play upon holy days. Topography, climate, and season each influences the forms of play. Whether it is cold or hot, wet or dry, rain or snow, all of these variables influence play in a variety of ways. For most children the kinds of play are determined largely by seasons, varying from boating and swimming in the summer to skating and sleighing in winter. Even marbles, kites, ropes, football, basketball, baseball, tops, and so on, are in vogue in certain seasons. Fads and fashions result in the introduction of new games, such as miniature golf, bicycling, yo-yoing, and the like. Space, or lack of it, conditions games. Running, chasing, throwing, jumping, swinging, and outdoor group games require space and are popular with most children. Lack of space may not only limit the kinds of games but may also result in serious hindrances to the development of the physical and mental activities of children. Children need more than exercise; they need training in team work and other

types of co-operation which foster mental alertness and moral qualities. Companions or lack of companions also influence the kinds of play. Children in the country, or those in the city who are housed too closely, may be limited in opportunities for play by the lack of a sufficient number of players to carry on the game. All of these and many other factors should be taken into account in providing a healthful play life.

What Children Like to Play

The games that children like to play most vary with sex and age. Everyone has observed the disgust of the boy of fifteen with the games of the boy of eight. Girls at various ages dislike many of the types of games played by boys, and boys usually cannot tolerate the games played by girls. All of these variations and differences have been subjected to careful study and observation, the results of which make us aware of changes in play interests.

Observations of children at play made by several investigators disclose that toys, blocks, sand, clay, etc., are enjoyed most by little children. Boys between two and six seem to prefer balls, crayons, and blocks, taking special interest in constructive play with blocks and in active play with wagons, trucks, trains, etc. Girls of these ages will play with such toys, but they show preferences for household playthings, such as dolls and materials, clay, crayons, cubes, scissors, and wooden animals. The length of time children of this period can be willingly interested in such toys and games varies from six minutes to an hour. Play for the most part is individualistic; that is, each child plays for himself, even though he may be in a group. Little talking to other children takes place during play of this kind. It has been estimated that 90 per cent of children of two to four years play alone, and that 70 per cent of children from five to six years of age play alone.

Studies of the games which both children and adults like best reveal some interesting facts. One study (Lehman and Witty) employed a list of two hundred games from which children from the third grade up were asked to check those they had played during the preceding week. The games checked most frequently by *boys* of ages five, ten, fifteen, and twenty were as follows: age five: playing with a ball, blocks, a wagon,

playing house, playing horse, hide-and-seek, tag, playing school, and playing in a sand pile. Age ten: football, baseball, boxing, catch, riding a bicycle, basketball, wrestling, skating, and marbles. Age fifteen: basketball, football, driving a car, tennis, watching athletic sports, hunting, going to movies, boxing, and reading books. Age twenty: having "dates," watching athletic sports, football, listening to the radio, going to movies, driving a car, reading the newspapers, tennis, and baseball. The games checked most frequently by *girls* of these ages were as follows: age five: playing house, playing with dolls, with a ball, playing school, drawing, mulberry bush, playing with blocks, skipping, making things, and jumping rope. Age ten: playing the piano, going to movies, looking at "funny" papers, playing with dolls, roller skating, riding in a car, reading books, playing school, jacks, and listening to the radio. Age fifteen: reading books, going to movies, social dancing, playing the piano, riding in a car, having "dates," watching athletic sports, going to parties, picnics, basketball, and gymnasium work. Age twenty: going to entertainments, social dancing, playing the piano, having "dates," hiking or strolling, going to the movies, reading books, watching athletic sports, card games, and riding in a car.

A study of this list will reveal that boys engage more than girls in games involving competition, action, and organization. Girls, in other words, appear to be more individualistic, less active, reading and going to the movies more than the boys. At age five to ten both boys and girls are interested in imitative games. At age fifteen this type of game is no longer played. The change comes gradually but seems to correspond with the maturation processes and to be completed by the beginning of puberty. After the physiological changes accompanying this period, "dates" occupy an important place in the play life of boys and girls. Such play activities as climbing and skipping the rope appear to be at their height from eight to ten, and after that to decline in interest to age fifteen when they are no longer enjoyed. The total number of play activities engaged in decreases rapidly though gradually from age eight to twenty-two. Participation in athletic sports, as well as watching them, seems to be of interest from ages ten to twenty both to boys and girls. The study also reveals that children retarded in school age tend to engage in a greater number of social activities than

do children who have made normal progress. Exceptionally intelligent and gifted children read more and engage less frequently than average children in social plays and games, while dull children read less and engage more in social and active games. Play thus varies with physical and intellectual development as well as with the environmental factors noted above. (7, 9)

Relation of Play to Teaching

A teacher who observes the play life of children will not only learn much about children, but also about ways of improving her teaching. If she can introduce an element of play into the classroom, she can make play a help in motivating school work. Play challenges interest because it furnishes an occasion for many pleasant feelings and emotions. It is stimulating also because of the emotions accompanying it. It is, therefore, a type of behavior that is useful in developing favorable attitudes toward school and school work. The teacher who can use a reasonable amount of it will make her class an enthusiastic one.

The educational values of play as a whole have been summarized as follows: (a) It promotes health by providing free and spontaneous exercise. (b) It gives first-hand contact with things, and in this manner broadens children's knowledge of physical properties and their relationships. (c) It tends to develop ideals of fair play, loyalty to the group, good sportsmanship, courtesy, and the like. (d) Through play children may learn to observe rules, to co-operate with others, to give close attention, to obey leaders, and to win and lose. (e) Play, often better than formal training, develops muscular co-ordination and thus lays the foundation for the acquisition of vocational skills. In fact, carefully directed play will achieve many of the final aims of education. In many respects it has greater educational value than work. (4, 7, 9)

THE URGE TO MASTER

Early Forms and Development

The term "mastery" is used to describe the tendency in human beings to dominate other persons. This tendency is

likely based on a more fundamental one observed in the child in his efforts to overcome obstructions. The protective responses, including the expressions of rage, appear to be the earliest expressions of the urge. When interfered with in any way, the child seeks to remove the interference and to master the stimulus. When held, for example, the child soon gets angry or goes into a rage. Before doing so, however, he pushes, pulls, tugs, and so on, in an effort to get free of the restraining stimulus. Soon he learns various ways of surrounding, overcoming, getting out of the way of, or directly attacking any object or person that stands in his way. In so far as he can treat people in this way, he develops the desire to make them conform to his wishes, and tries, therefore, to become the dominant figure in the home, or any other social group. There seems to be a high degree of satisfaction in overcoming the obstruction offered by anything, however, and this becomes an important impulse in motivating the work of the child. Failure to overcome obstruction nearly always results in grief or rage or kindred emotions. The mastery urge may be developed as a means of avoiding this type of unpleasantness.

Modification and Uses

The modification of the emotional elements associated with mastery is a matter of some concern. The young child usually learns from his own experience the futility of screaming, fighting, or of trying to demolish physical objects. It is to be hoped that his training is such that he will find it necessary to modify this type of behavior in dealing with human beings. The parent who allows the child to master a situation by means of an emotional outbreak is running the risk of developing in the child a very undesirable group of habits. Wise guidance on the part of parents and teachers, however, may result in hastening the modification of emotional behavior so that the total response will conform better to social standards. This guidance requires an understanding of the child's disposition in this respect, and an effort to call his attention to better and more effective means of overcoming his difficulties. When the emotional aspect is brought under control, leaving the mastery urge to seek expression in a more or less controlled manner, it becomes a very useful urge. It is helpful in sustaining activity

not only in dealing with persons who are recognized as worthy opponents but also in solving difficult problems, such as special assignments and work to be done. The urge is best aroused by a challenge of some kind that will arouse in the young child an attitude of determination. (5, 9)

RIVALRY AND SOCIAL APPROVAL

Definitions

Expressions of all of the tendencies described above are often enlivened and sustained by other tendencies, such as those to compete with a rival, to secure social approval, and to avoid social disapproval. The tendency to compete with a rival involves the mastery urge under special conditions, as may be exemplified in competition. The urge to secure social approval is that of desiring the approbation, praise, or approval of others, especially of one's friends or superiors. All of these seem to be powerful urges when aroused in children or adults.

The Urge to Compete

This tendency is manifested in both play and work, and has an important part in vitalizing either. It gives zest, excitement, and heightened energy to activity, especially when there is an element of challenge or dare in the total situation. The element of challenge arouses the tendency to excel, and the element of dare arouses the desire to avoid social disapproval. The total activity, when motivated by all of these, is usually extremely vigorous. For this reason, this is a useful urge to arouse in connection with school work.

The Use of Rivalry in School Work

Group rivalry is helpful in sustaining vigorous work if it is properly directed. Opposing groups should be about equally matched, and each group should be required to exhibit fair play and strict honesty in the contest. Otherwise, simple contests may result in strife among pupils and become the cause of numerous undesirable attitudes. Children, in the main, are poor losers until they are taught to be good losers. Teachers should make it a point to overcome the annoyance of failure to win by praising success in being good losers. Group contests

improperly conducted are worse than no contests at all, especially if parents or other persons outside of school become involved in the children's quarrels and disputes. Contests between classes, between schools, or other groups that may be arrayed in friendly rivalry are often productive of good results in raising scholastic averages and may result in better work on the part of individuals. It is relatively difficult, however, to develop intensive rivalry as a means of getting groups of children to be more studious, truthful, and honest. It is still more difficult to prevent the desire for social approval from influencing children in the wrong direction when rivalry is in vogue. (5)

The Use of Social Approval and Disapproval

At first the child cares chiefly for the approval of his parents and other grown-ups whom he likes. Later, when he starts to school, many of the child's activities are prompted by a desire to please the teacher, and thus to secure her approval. The teacher in the elementary grades needs only to express a wish to have it carried out by most pupils, especially if she loves children and succeeds in making them love her. As children become older, however, they come to care more for the approval of their playmates, for the class gang, or group, than for the approval of parents or teachers. This change comes about partly as a result of the growth of social consciousness in the individual child, and partly as a result of weaknesses and foibles in the teacher which the child is now able to discern. Children in the intermediate grades are especially prone to seek the approval of the gang, and if possible, they will become extremely critical of the teacher. This happens particularly when the teacher appears to them to be unjust or unfair, or even "hard-boiled."

The successful intermediate teacher will avoid the appeal to personal approval and stimulate group approval in motivating school work. This is especially helpful in dealing with disciplinary problems. If the teacher permits her class to develop the habit of approving the bully, the impudent pupil, the merry-maker, the miscreant of any kind, she will soon lose control of the class morale. On the other hand, if she can succeed in bringing down the scorn and disapproval of the class upon the unruly one, her disciplinary problems are almost half solved. Often

the teacher makes the error of ignoring the children's sense of justice and its influence in determining the behavior of the individual child. What she needs to do is to make the class as a whole feel responsible for the achievement and discipline, and in this way to motivate the children themselves to stimulate the sluggard or disobedient child in the right direction. When used in a judicious manner, the urges to secure social approval and to avoid social disapproval can be made strong allies in the classroom. (5)

SUBMISSION

Nature of the Tendency

Most of the tendencies to which attention has been called prompt the individual largely in the direction of self-assertion or self-expression. In mastery we see the efforts of the individual to overcome obstacles; in rivalry we find the effort of one to distinguish himself; in the striving for social approval we find the effort of one to become the center of attention of others. All of the urges that prompt the individual to engage in these types of behavior are useful as motives to action when the modes of expression are carefully planned, directed, and controlled. But the effort in any instance to get into and maintain a position in the "limelight" through satisfying these tendencies is often impossible. There are numerous obstacles which cannot be overcome, persons and groups which cannot be excelled, and persons whose approval cannot be secured at all times. Failure and its annoyance are forced upon the individual every day, and he has to suffer from being unable to satisfy some one or all of the tendencies at some time. In order to prevent the individual from suffering too intensely, society permits and encourages at times the opposite of all these tendencies and modes of behavior through the *urge to submit*, and thus of submissive behavior. Other things being equal, human beings tend to submit, and to find satisfaction in doing so, to any stimulus or situation that cannot be mastered, excelled, or conquered.

Origin and Uses

The urge to submit is likely the outgrowth of the individual's helplessness and dependence upon others in infancy. Infants

learn to submit to the desires of the mother, for example, in numerous instances, because this is the only way out of difficulties. Besides, non-submission is often annoying on account of deprivations and punishments. Moreover, children learn to seek the assistance and leadership of older persons and to depend upon others to help them with numerous problems of adjustment. Children recognize the superior performances of their elders and see the differences between these and their own. All of these outcomes of training, together with love for their parents, fear of punishment, and perhaps various other factors, prompt each individual to submit to others under certain conditions without any feelings of restraint or annoyance. Not only so, but he is also rewarded in a variety of ways when he exhibits submission. He shares their approbation and praise, meets the difficulties that confront him in satisfying other tendencies, and learns to derive pleasure through submission.

It is this type of training, it seems, that develops the tendency not only to submit to other persons but also to the unconquerable, the inevitable, and even to the mysterious, and to regard such stimuli or situations with feelings of fear, awe, respect, and even with veneration and love. Out of this complex of tendencies and feelings comes such forms of behavior as hero-worship, worship of God, submission of women to men, and the like. Some of these are highly important for education.

Hero-Worship

The hero-worship type of submission is found in every normal person. Each one at some time in his life has a hero or personal ideal, that he adores or worships in a variety of ways. This person is usually one that the worshipper would like to be near, favored by, be like, and so on, because he appears to satisfy all of the worshipper's tendencies, especially those which this individual himself cannot satisfy. The hero becomes an object of study and thought and a great influence in the life of his worshipper. Studies have been made to determine from what source children derive their ideals.

It has been found that young children derive their ideals from their immediate acquaintances, such as father and mother, older brother or sister, or some neighbor. As they grow older children increasingly derive their ideals from the great char-

acters of history or leaders in contemporary life. One study shows, for example, that acquaintance ideals diminish from 78 per cent at six years of age to 5 per cent at sixteen; that ideals from history increase from 7 per cent at six to 61 per cent at eleven, but the percentage drops to 48 per cent at sixteen; that ideals from contemporary life increase from 9 per cent at six to 19 per cent at eleven, and to 39 per cent at sixteen. Girls and boys both, it was found, choose male ideals more frequently than female. The character elements which receive increasing emphasis in the minds of children include honesty, bravery, patriotism, leadership, and intellectual ability. Small children also idealize those persons who are "good" to them, who pay them attention, and who give them things.

Use in Teaching

The significance in teaching of the urge to submit is great. It suggests the importance of worthy ideals. It indicates that great stimulation toward the development of desirable character traits as well as modes of action can be given to the child. In fact, one of the important outcomes of education is the development of ideals in individuals, the motivation of the child to respect, admire, esteem, and imitate the makers of history. The child is led gradually to discover the ultimate weakness of mankind in general and to adopt the religious view of life which stresses the virtues of heroes more perfect and more admirable than ordinary men, and the values of becoming like them. It is not good pedagogy to break the child's ideal by emphasizing its weak points, but it is good pedagogy to point out its imperfections, when these are present, and to indicate how they could be improved in himself. The present tendency in history to idealize the characters and to present them as having no flaws is a questionable practice. By the time the child is old enough to understand and appreciate the causes of the Civil War, for example, he is old enough to realize that men on both sides were neither gods nor devils. A better type of training comes from giving the pupil an impartial view of conflicts between men, and from attempting to get him to raise his ideals to higher and higher levels.

It is in this connection that religious training has some of its greatest value to the individual. Religion, of the right kind,

personifies the virtues of a race or of all mankind, and attempts to keep before the individual the ideal character who is worthy of his imitation. Everyone needs this kind of ideal to prevent him from becoming undesirably pessimistic regarding the shortcomings and weaknesses of mankind in general. Moreover, religion emphasizes the ideal teaching and life that one may aspire to when he is stunned by the realization of the inconsistencies of men. The resignation or submission to such an ideal is a healthful form of behavior for the average person. It is especially beneficial and valuable to the boy or girl in making the transition from childhood to youth, that is, during the period of adolescence. It is at this time that the individual is most likely to lose confidence in the ideals of earlier childhood and to lapse into a life of sensuous enjoyment and thus to become a profligate or a criminal. (14)

SYMPATHY

Nature and Development

Sympathy is usually defined as feeling with or sharing the emotions of another. It is, however, more closely allied with love, sadness, grief, pain, and other similar states, than with the stronger emotions of anger and fear. We are, in other words, more apt to "feel with" someone whom we love or that we like than we are with someone whom we dislike. We "feel against" rather than with the person or thing we dislike. The importance of sympathy is that it enables human beings to understand one another and so to live together more harmoniously. Mixed with pity, sympathy becomes a force within individuals for helping other persons who arouse such states within us, though sympathy itself, apart from other tendencies, does not prompt us to become altruistic or helpful.

Our main interest is not in the act of sympathizing with others, however, but in the craving for the sympathy of others that appears in both children and adults. Through a variety of experiences the young child acquires the art of arousing sympathy in others and comes to enjoy its expressions. He discovers, for example, that his own feelings of dejection are responded to by others with attention, caresses, and other pleasurable forms of behavior. In this manner he gradually

develops a group of activities with which he plies his art. These range all the way from whining and complaining by children to the narrations of misfortunes and hardships by adults. These modes of behavior are, in the main, socially undesirable and need, therefore, to be modified. No one, for example, cares to listen to the complainer, the whiner, or to the person who pathetically pours forth a stream of talk about operations, bank failures, losses, and the like, indulged in for the purpose of arousing sympathy.

Over-Development

The craving for sympathy in the child may become over-developed, especially when sympathetic parents respond in a highly pleasurable manner to every expression of pain or distress. The child comes to feign pain, sorrow, or anguish merely to enlist the sympathy of others and to enjoy its fruits. If rewarded too often and too much, the child may develop a whining, complaining attitude toward nearly every situation that involves a certain amount of difficulty. Adults may resort to hysterics, or other severe outbreaks, to attract the attention and arouse the sympathy of those they love best. The over-development of the craving leads to many undesirable and abnormal types of behavior. Children have been known to resort to such extreme measures as self-inflicted bodily injuries, such as cuts and bruises, as a means of gratifying the urge.

It may be seen, then, that one of the most serious problems confronting both parents and teachers is that of knowing when to show sympathy. Before it is over-developed, children very soon learn what the occasions are to which sympathy is usually attached, and they learn also which persons are most affected by their expressions of the desire and who will offer the most satisfying types of comfort and consolation. The ease with which the craving is normally controlled suggests, then, that parents and teachers should study the problem carefully. Parents run the risk of over-rewarding the cravings in children, and teachers go to the opposite extreme. But either can be too sympathetic, or too unsympathetic, for the greatest good and happiness of the child. There seems to be a happy medium to be sought by both parents and teachers. In most instances when children manifest the craving, their attention should be

directed toward other things. But a careful study should be made of each to determine its merits or demerits for each type of reward. Certainly, children should not be rewarded for complaints they make when they fail to solve problems, or to meet any of their obligations because of this and that misfortune. Physical pain or mental anguish are the chief things for which sympathy should be shown. (9)

GREGARIOUSNESS

Meaning

The term "gregariousness" has been used to describe the tendency of many species of animals to herd or congregate into herds, packs, or assemblies. Cattle, buffaloes, sheep, wolves, and wild dogs are of the gregarious type, living and roaming about together, whereas tigers, lions, bears, and many smaller animals are of the solitary type, living and roaming much to themselves. Man is likewise gregarious in that he organizes clubs and societies and lives often in towns and cities. Man has always, it seems, sought the companionship of his fellows. Individuals derive satisfaction and pleasure from being with their kind, and suffer annoyance, under certain conditions, when cut off or separated from others. The tendency is stronger in some individuals than in others, but children and adults alike exhibit satisfaction in belonging to particular gangs, clubs, crowds, sororities, fraternities, etc. This satisfaction is said to be due to the gratification of the gregarious tendency.

Origin and Development

While all of these activities manifest a gregarious tendency in man, we doubt its being an inherited one. That is, we should say that human beings do not herd or flock together because they have a fundamental craving to be and live together, but because of the opportunities they have in groups of finding expression for certain tendencies. They are inevitably thrown together and develop the tendency as a result of the association. Gregariousness appears to develop as a product of the usual training given to infants. The infant can be trained to remain in the crib alone for hours at a time without expressing an urge to be with the mother. It can also be trained so that it will

demand the constant attention of the mother, nurse, or others of the family group. The child's first "social consciousness" seems to grow out of the family contacts and experiences. The constant association in the home, the family name, daily routine, visits to neighbors and the invariable return home, gradually develop a sense of "belongingness." This sense or feeling seems to give rise to the gregarious tendency—the desire to be with his own family group.

The child at first is not socially minded in the sense that he wants to be a member of a group and to participate in group activities. Being dealt with as an individual in the family group, and experiencing individualistic types of tendencies, it is several years after birth before the child exhibits gregariousness. The young child, for example, though thrown in with a group of children at play, plays alone. He is interested in what the other children are doing only when his attention is attracted to them. Whatever conversation he engages in is in the nature of monologues that do not serve any social purpose. Such attachments as the child forms are for adults, such as parents, adult friends, teachers, etc. In dealing with other children, a child's behavior is, in most essential respects, determined by what he has been specifically taught, and not by a gregarious tendency that prompts him to behave in certain ways toward them. There are, to be sure, various other forms of social behavior based on the imitative tendencies. During the entire preschool period the child is busily engaged in acquiring social modes of behavior through imitation.

Informal Group Stage

During and after the first year in school, children begin to exhibit group consciousness. This development appears to be the result of these children being associated on the play ground and in the school room and forced to play together. If left to themselves, they frequently form groups of eight or ten, usually according to previous acquaintance and without regard to sex. This arrangement usually leads them to engage in competitive games. These games do not involve team work, but are characterized more by individual performance, each child attempting to excel the others. The groups are unorganized and unrestricted as to members, and may vary in personnel from day

to day. The children often assume an attitude toward each other which is copied from adult life. For example, they give advice, give instruction, and even commands with regard to playing fair, dividing the spoils evenly, and the like. In brief, group behavior during this stage is a reflection of home training, and it is undergoing a process of modification. It is at this time the child meets the first persistent requirements outside of the home, and that his parental and teacher attachments begin to weaken.

Organized Group Stage

After two or three years of school experience, children of different families of near the same socio-economic level, and of the same sex and chronological ages, begin to organize themselves into bands or "gangs." These usually vary in size from ten to fifteen members, each of whom is elected to membership and initiated by elaborate ceremonies. In these ceremonies the "secrets" of the gang are made known, to which the initiate is duly and solemnly sworn. There is usually a badge of membership, and various secret passwords, gestures, and signals. The gang usually holds regular meetings at specified places, such as at a shanty, vacant lot, the home of a member, etc. The activities of the clubs are usually social in nature, reflecting the social life from which its members come. Because of the tendencies of children to imitate their elders, the activities of the gang are vicious or commendable according to the nature of the community life about them. Gangs discovered in the slums of New York, for example, included in their activities such actions as stealing and collecting such articles as candy, cigarettes, electric bells, golf clubs, and balls. Other gangs made their activities include such atrocities as burning buildings, pilfering, and beating up policemen. The vast majority of gangs, of course, engage in harmless games and feasts, and in such activities as hunting, swimming, theater-going, and dancing. The typical gang is usually dominated by a leader whose initiative and resourcefulness determine its activities and power. The leader is typically larger, a year or two older, and socially more mature than the other members, and he is usually above normal intelligence and a good sport.

The values of such gangs to particular children, when they

engage in harmless activities, is very great. It is here that some, if not most, children get the best social training they ever receive. The gang rules and practices place stress upon such traits as loyalty, fair competition, co-operation, and strict obedience to the leader and the rules. Cases of infraction of the rules or disorderly conduct are usually "tried" by the club as a whole, and the decisions reached are nearly always fair and intelligent. Many of the trials are very good imitations of regular adult courtroom procedure. The clubs serve as nothing else can to divert the child further from the parents, and to inculcate ideals of loyalty and devotion to a group. Membership in the club is often the chief motivating influence in an individual child's life. Though a great many "chums" are made during this stage, permanent friendships depend upon activities of later stages.

Wise supervision is possible and effective during this stage of children's activities. The supervision should not be the type, however, that inquires too closely into children's secrets, but which directs the activities of the gangs into socially desirable channels. The teacher may do this to a large extent if she will make herself somewhat of a comrade and not a dictator to the children. Here, conduct in the classroom will determine largely whether she is agreeable to the children. She can win their respect and admiration often by making the classroom atmosphere less artificial and strained than it usually is. There is no reason why the class should not be organized into a club for the purpose of solving various problems of common interest, such as presenting a school play, having a Halloween or Christmas party, or engaging in various other social activities. A wide-awake teacher can go a long way toward accomplishing worth-while results. The main outlet for gang activities is in extra-curricular activities, however, to which not only individual teachers but school authorities as well should give much attention.

Maturation of Gregariousness

The final stage in the development of gregariousness is reached during the period following the organized gang stage. This is the period previously described as adolescence, which begins normally with the maturation of the functions of the sex organs. The early part of the stage is sometimes called the "awkward

age," because of the self-consciousness felt by both boys and girls. They want to walk, talk, and act like adults, but do not know how, and their self-consciousness is increased and aggravated by the comments of their elders. It is during this stage that boys and girls begin to take an active interest in each other and to participate in the same social and play activities. Their mental development permits a keener insight into social situations than was formerly the case, and opportunities and practices in social activities cause a rapid development to take place in their ability to participate in an adult manner.

One of the most characteristic types of behavior is that engaged in by the two sexes in their efforts to attract the attention of one another. Up to this period, there is a marked antagonism between the two sexes, but at this time there is a show of greater tolerance and more active interest. Though claiming to disdain girls, boys often "show off" before them in order to attract their attention, using athletic prowess, physical strength, or other devices for accomplishing their ends. Girls, on the other hand, show tendencies toward display of personal charms and coquetry. At this time both boys and girls lose interest in gang activities and shift their forms of interest to more adult-like activities, as has been shown above.

There is also a changed attitude toward the adults. By sensing his own development, and having been separated frequently from the parents, the adolescent no longer submits unquestioningly to those in authority. He yearns for greater responsibility, and he begins to draw apart from the adults, even though he is greatly interested in what they are doing and how they are doing it.

Because of the dangers which attend this period, it is frequently called the "dangerous age." Most of the dangers are centered about the sex problem. Because of the changes in the sex organs, and as a result of the greater freedom of action and social participation accorded to adolescents, and because of the frequent arousing of sex excitement, many young people cultivate a morbid curiosity and develop habits of self-abuse. This danger is not as great in the case of girls as it is in that of boys, but it is present and merits close supervision. Most of the dangers have been over-emphasized by numerous writers, for such activities can be avoided in the vast majority of cases.

This may be done by careful advice and training in physical hygiene, and by the provision of healthful social recreation.

The final maturation of gregarious tendencies takes place in the later adolescent period. At this time boys and girls become conscious of approaching maturity. There is an increased sense of power and independence, and a keener interest in the affairs and activities of adult life. There is a tendency to look into the future with the view of choosing a vocation and of assuming other adult responsibilities. The mutual attraction between the sexes is now obvious, but it is accompanied by a changed attitude on the part of girls. This change is in the direction of greater interest in boys older than themselves. But there is now no longer any secrecy regarding such attractions, and "dates" become one of the chief forms of recreation. If there is a "dangerous period" in life, from the standpoint of immoral practices, it is most likely to come at this than at the earlier period. The danger is further augmented by the somewhat estranged relations between parents and their children. Now is the time they need leadership of the right kind to keep them interested in the things that are considered socially worth while. It is at this stage that religion plays its most significant role in the life of individuals, particularly through the influence of religious leaders. (2, 9, 14)

THE TENDENCY TO IMITATE

Origin and Early Forms

The tendency to imitate expresses itself in crude form in such reactions as laughing, crying, crouching, and running, when others do these things. The most common expressions, however, are less definite activities, such as awkward efforts to copy, reproduce likenesses, mimic or ape gestures, movements, play, work, and even social behavior of the most complex types. Such efforts to imitate are made by children very early in life. The young child imitates those about him in an endless variety of ways, and appears to derive satisfaction in doing so. The satisfaction derived seems to be due to the fact that he finds this type of behavior a short-cut in learning, and because he is often rewarded with the approbation and praise of his elders. Gestures, movements, and sounds seem to be the first types

of real imitation observed in the child. Lack of muscular development and co-ordination limit the child's efforts to faint likenesses of the stimulus pattern, but the efforts become more accurate with maturation and learning. In speech, for example, the child first imitates the general intonation and sequence of sounds, but later when the vocal organs are more mature, he reproduces the sounds of words with definite accuracy. It is much the same with other forms of behavior. The child continues to try to copy a great variety of actions of others until he modifies his first attempt so that they correspond to the models he observes.

Advantages and Disadvantages of Imitation

Imitative tendencies seem to pervade the whole of human life, and are, for this reason, among the most powerful forces with and against which educators must work. Custom, convention, vogue, taboo, and the like seem to be largely expressions of their power. To follow the example set by the crowd, to do what others do, and as they do it, brings the approval and the benefits of society. To violate prevailing custom or convention brings criticism and scorn, and even punishment. For this reason imitation is a great conserving influence by means of which society perpetuates its institutions, its cultural attainments, ideals, inventions, and the like, which are passed on from one generation to the next. As a method of learning it is of great value in nearly all fields—in art, literature, industry, religion, and character building. In all of these it should be encouraged. It is a distinct advantage to urge the child to imitate worthy social creations which come to him as an heritage.

As useful as imitation is, however, it is fraught with certain dangers against which the educator must work. When wrongly used, imitation leads to stagnation instead of progress. This occurs when the individual or group follows blindly the patterns of work and conduct set by others instead of trying to improve upon their manner of procedure. The school room is no place for the "copy cat," but it is a place where the child should strive to imitate not one but numerous models and be taught to discover merits or demerits in each of them. Constructive criticism and thinking, as a final product of teaching, will grow out of the effort to evaluate various models of action. Thus the teacher

should stress imitation in a general way but not the imitation that involves blind copying of particular models. The teacher herself should strive to be an example worthy of imitation by children—in conversation, method of work, and sincerity. She should make it her special business to call attention to good, inspiring, and admirable examples of character and conduct portrayed in the school subjects or known to exist in the community. (4, 9, 12)

EXERCISES

1. Show how social tendencies differ from physiological and emotional tendencies.
2. Why do human beings play? Is this an inborn or an acquired tendency? Give five reasons to support your answer.
3. Can you think of a better definition of the tendency to play than that presented in the text? Examine the references for one or more other definitions.
4. Of all the tendencies discussed in the text which is the best to use as a motive to get children to do school work? Show why you choose this particular tendency.
5. Which of the tendencies discussed in the text is probably most frequently over-developed in school children? Why is this the case?
6. Describe the development of gregariousness in children.
7. Discuss the values of religious activities as a means of finding expression for various tendencies.
8. Imitation has its advantages and disadvantages. What are they in each case?
9. "Children should never be made acquainted with the imperfections of persons they have sought to imitate as ideals." Criticize.
10. Summarize the educational advantages of each social tendency.

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CHAPTER XII

PERCEPTUAL-MOTOR LEARNING: ACQUIRING MOTOR SKILLS

INTRODUCTION

General Characteristics

Purpose of the Chapter

In this chapter we shall continue the discussion of perceptual-motor learning with special reference to the acquisition of such motor skills as card-sorting, driving a car, handwriting, typing, and playing tennis. Our purpose is not to describe the manner in which each specific skill is acquired, but to indicate the fundamental nature of such learning and the principal factors involved in it. In doing this, we hope to furnish the teacher with suggestions that will enable her to apply the laws of learning, in particular, to the specific cases of learning which it is her task to direct. We shall try to indicate, at least, the means by which the teacher can assist pupils in economizing their time and effort and help them acquire a high degree of efficiency in motor performance.

The Complexity of Perceptual-Motor Learning

The complexity of the type of perceptual-motor learning we are now considering should be apparent to the teacher. This complexity may be illustrated by calling attention (a) to specific tasks involved in several examples of such learning, and (b) by attempting to indicate the neural processes involved in one or more examples.

EXAMPLES OF PERCEPTUAL-MOTOR LEARNING. (a) *Card-Sorting.* When sorting cards by placing them in separate stacks, the learner's task is not so much that of acquiring a highly co-ordinated group of muscular responses as it is that of making, at the appearance of a given stimulus, a movement already under partial control. It is necessary, for instance, for

the learner to recognize the word or object on each card, to make a prompt accurate movement toward the stack, and to lay the card where it belongs. The act of recognition depends upon such specific tasks as the following: (a) becoming familiar with each separate card, (b) distinguishing a given card from all others in the group, (c) keeping in mind the spatial arrangement of the stacks, (d) mentally referring each card to each stack, and (e) deciding upon the particular movement to make. The motor aspect of the performance involves, in turn, such specific tasks as the following: (a) making a quick movement in the direction perceived, (b) placing the cards on the stack, and (c) picking up another card and bringing it in the range of vision for the act of perception. All of these separate mental and motor events must be integrated and co-ordinated so that the total performance will go on with a high degree of ease and accuracy. The typical performance of the learner in acquiring such a skill is a high degree of trial and error activity, particularly in the early stages. (5, 6)

(b) *Mirror Tracing.* A familiar example of perceptual-motor learning frequently employed in psychological laboratories to illustrate the specific tasks of a learner is that of mirror tracing. This usually involves the task of tracing a five-pointed star while looking at its reflection in the mirror. The mirror serves to reverse the perceptual elements of the situation in that the direction of movement in the mirror is opposite to that expected. Thus, the learner, even though an adult, is forced to discover new modes of response, or else ignore visual cues and fall back on kinaesthetic sensations to guide his movements. When confronted with such a situation, most learners attempt to move in the directions indicated by the visual percepts; that is they attempt to react to the new situation with previously acquired responses. As a result, they usually go through a period of mental and muscular confusion in which there is a great deal of error and little success. Finally, however, through a trial and error process, they gradually eliminate the errors in favor of successes and eventually learn to respond to the new visual cues. Other learners assume a critical attitude toward the situation, and attempt to analyze its possibilities in advance. If they decide that the visual cues can be ignored and kinaesthetic cues can be followed instead, they usually adjust to the situation

without suffering a high degree of confusion. As a result of this critical attitude these learners usually master the movements involved in tracing the star much more quickly than do those who employ the trial and error procedure. Regardless of the method of attack, however, each learner will make a large number and variety of errors, such as getting off the line, reversing direction of movement, and stopping the pencil, during the initial stages of learning. (12)

(c) *Handwriting.* Handwriting is an example of perceptual-motor learning in which the tasks of the learner vary from one stage to another. In this activity, the stimulus elements play an increasingly important part and the movements, though not especially new or novel, have to be organized into new patterns which will operate smoothly and rhythmically. With regard to the stimulus or situation, the learner is confronted with such tasks as (a) perceiving the shapes of the various letters and the direction of the lines that compose them; (b) perceiving the ways in which separate letters are connected together in words; (c) noting the fact that the stimulus patterns are arranged in straight lines or on lines; (d) observing that written words are symbols of printed and spoken words and useful means, therefore, of communication; and (e) learning to revive images of these factors. With regard to the motor aspects of learning: (a) learning to assume a correct writing posture and position at the desk; (b) learning to hold the pencil or pen; (c) learning to follow or stay on the line, not only by visual cues but also by turning the hand over to the side by pronation; (d) learning to avoid excessive finger movements in favor of arm movements; and (e) learning to co-ordinate all of these separate movements to produce a smooth, rhythmical movement and a legibly written product. (5, 6)

Neural Processes. The complexity of perceptual-motor learning may become still more apparent by attempting to give an account of the neural processes involved in a given example, such as handwriting. Let us note, first, the possible neural pathways involved in the performance of copying a word after the process of writing has been acquired. These seem to be somewhat as follows: (a) stimulation of the retina by the word to be written; (b) transmission of the impulses from the retina to the visual area of the cortex; (c) widespread cortical activity

involved in perceiving or recognizing the word and deciding to write; (d) transmission of impulses from visual and perceptual centers to motor centers, and from these to the muscles of the arm, hand, and fingers; (e) stimulation of kinaesthetic receptors and the arousal of impulses by the moving muscles; (f) transference of these impulses to the kinaesthetic centers in the cortex and from there back to the muscles; and (g) execution of the writing movements. The writing movements under way are controlled mainly by kinaesthetic impressions rather than those from the visual area. This is indicated by the fact that a person can write almost as well with his eyes closed as with them open, except for proper alignment, size, spacing, dotting i's and crossing t's, etc., which are controlled by visual impressions. (12)

Before learning has taken place, the various neural circuits by which these different centers are connected with each other are closed. Because they are closed, the learner is unable to make the movements. He may receive the stimulus, experience the motive, etc., but he is unable to make the movements. Consequently, the nervous energy is diffused to reactors usually brought into action during a crisis or an emergency. The diffusion that takes place seems to be due to the presence of old conduction paths which have been established by structural growth or previous responses to similar situations. At any rate, the learner makes a large number of inappropriate and superfluous movements; he grips the pencil tightly, makes facial grimaces, assumes awkward positions, and shows considerable tension in the muscles of the entire body. Many of these responses are doubtless due also to efforts to inhibit them and to direct the flow of nervous energy to appropriate reactors. Gradually, through repeated efforts to respond, the nerve impulses initiated in the cortex from the awareness of the motivating factors, and from the stimulus pattern, are all integrated so that they follow new pathways from one cortical center to another and from thence to appropriate reactors. Meanwhile, old pathways are blocked through inhibitory efforts and disuse, and gradually cease to function. While the individual is gaining conscious control of the appropriate responses, the process of co-ordination goes on and makes possible a smooth and rhythmical type of movement free of inhibitory effects and of gross errors.

MAIN FACTORS INVOLVED IN PERCEPTUAL-MOTOR LEARNING

Summary

The foregoing discussion should indicate the chief characteristics of this type of learning. These are: (a) a motive or group of motives to respond to the new situation, both at the beginning and during the period of learning; (b) a high degree of attention to the situation by means of which the learner becomes progressively aware of its various elements; (c) repetition, practice, or drill during which the learner strives to satisfy the motive by reaching a set goal; (d) a progressive reorganization of responses in the direction of successful performance and the consequent elimination of errors; and (e) the final fixation of a pattern of responses appropriate to the situation, this pattern which is to operate apart from the necessity of conscious effort to control the detailed movements. These are, at least, factors that the teacher should keep in mind while she is attempting to direct the learning activities of children. Many teachers seem to think that there is very little they can do to assist the child in this type of learning. Thus, about all they know to tell the pupil to do is to "try, try again." But while such learning proceeds as a rule by the "trial and error" method of adjustment, we wish to emphasize the fact that the teacher has some very real tasks to perform. One of these is to cut down the waste of trial and error by stimulating and directing the learner step by step until he has mastered the performance. What she may do to achieve this result may be suggested by concentrating attention on each of the factors named or described above. (2)

Motivation

Need

In a previous discussion of the *law of readiness*, attention was called to the function of motivation in establishing new neural connections. In acquiring skills, a motive or urge which prompts the learner from within is one of the most needed factors. The reason for the need is the fact that the stimuli presented to the child have little potency of their own to call out the complex responses. To a large extent, in fact, the stimuli are imposed upon the child without his knowing or realizing the value to

himself of responding to them. What is there in the letters or words set before the child as a copy that will stimulate him to write? If he writes, there must be an additional stimulus that will prompt him to respond, or to try; and this stimulus is usually in the form of a social tendency. The child may be induced to try, for example, by the tendency to imitate, the desire to please the teacher, or a desire to compete with someone. No matter what the tendency or motive may be, it is an essential factor in getting and keeping the action under way; and the stronger the motive the more vigorous will be the responses and the more rapid the learning. We may say, then, that the teacher's first task in directing learning is to arouse a strong motive to acquire a particular mode or pattern of behavior.

Social Motives

Fortunately for the teacher, most children are already motivated to undertake various tasks. Through contacts with others, they also have some ideas of the nature of many tasks the school will impose upon them, and some notion of the values of being able to perform the tasks. In the absence of proper social contacts on the part of some children, the teacher may find it necessary to provide motives in the most artificial manner. Many children, in fact, often attend school several days or weeks before they enter into school activities with any degree of zest or enthusiasm. In such cases, the teacher will have to create situations which will arouse within the children feelings of need for the type of work they are called upon to do. Even if the pupils approach the task of acquiring a skill as a result of some tendency aroused by the teacher, the difficulties encountered in making satisfactory responses often block or inhibit the tendency before the skill is acquired. Thus, the problem of motivation is not only present in the task of *getting* the learners to try, but also in the task of *keeping* them trying.

Motivation as an Aim in Education

A few American educators consider the problem of motivation to be of such great importance that they make its solution one of the primary aims of the school. They try, for example, to create a social environment in the school in which the individual child,

will not only feel the need of new acquisitions, such as knowledge or skill, but will also desire and request the aid of the teacher in supplying his needs. The child, in fact, is never required or forced to do anything, but he is left free to do as he wishes. It is assumed that he will want to do the things other children are doing and from which they are deriving pleasure. While this type of motivation has some merits, it is not necessary to let the child discover needs and develop desires in such an informal manner. These can be aroused more artificially when necessary by direct appeals to native and acquired tendencies.

Special Types of Motivation

One of the best motives to use while learning is in progress is the desire for improvement and for achievement of set standards of performance. For this reason the teacher should devise ways and means of exhibiting pupil progress and achievement. Progress can be exhibited to the pupils by the use of learning curves or graphs, which show the rate of progress and the standing of a given pupil or a class over a period of time. Measures of progress include speed and form tests of various kinds. In measuring handwriting, for example, speed of writing may be determined at regular intervals, such as every other day, or every Friday, by taking a record of the number of words or letters the child is able to write per minute. Form or quality of writing can be measured by comparing the writing of a given pupil with that found in a standardized handwriting scale for the age and grade of that pupil. The scores or measures obtained in this or a similar manner can then be shown to the child or exhibited in a graph. In order to make a graph, the successive tests, 1, 2, 3, 4, etc., can be represented on the abscissa, and the measures of speed or quality of performance on the ordinate on a sheet of graph paper, and the curve drawn through the points of intersection of the two separate sets of lines. The curve will then represent to the pupil or teacher the progress of learning, and it can be shown to the pupil as a means of stimulating him to greater effort. Many teachers train pupils to keep records of the tests they take and to make curves of their own progress. This is a practice worthy of imitation by new teachers of any subject in which progress is of motivating significance. (7, 10)

Directing Attention and Understanding in Perceptual-Motor Learning

Need

The stimulating conditions to which a child is expected to react in acquiring a skill are often varied and complex. Too, children are usually careless observers, especially with regard to details, having a habit of reacting to most situations without attempting to analyze them. For this reason the teacher needs to exercise considerable care in helping them to understand particular situations. In fact, making the child discern the various elements in a total situation is almost as essential as arousing and sustaining a motive. If this discernment does not occur, the learning of the child is little superior to that of the animal which proceeds almost wholly by trial and error. Unlike the animal that makes its first trials and successes by chance random movements, however, the human learner can be induced to take a more rational attitude toward a given task. He can, at least, be induced to study the situation carefully and thus usually to understand the nature of the task to be done. (2)

Methods

There is probably no fixed method of procedure that the teacher needs to follow in making learners understand the nature of a situation, for each separate skill has its own particular problems. There is, however, a need for the teacher to devise ways and means of accomplishing this result. In teaching handwriting, for example, the teacher may set down a copy or model and point out the shapes of the letters on paper, in the air, or on the blackboard; or she may demonstrate such important elements as posture, holding the pencil or pen, pronation, muscular movement, rhythm, and the complete act of writing, while the children observe. In teaching a person to drive a car, much valuable help can be given by explaining verbally and by pointing out what should be done, "suiting action to the word" while the learner observes. In teaching correct form for athletic activities, the teacher will find it helpful to give pupils opportunities to observe skillful players in action and to suggest important features of the performance while the pupils are observing. All such instructions and demonstrations, it may be

pointed out, should not only precede actual trial and practice by the learner, but they should also be given and repeated and enlarged upon during and after practice. (7)

Sources of Models

In general, and as far as it is possible to secure them, good models should be exhibited to children. Although they are unable to imitate perfect models accurately, children have a strong tendency to reproduce striking likenesses of such models as are presented. Handwriting models, it is thought, should contain letters of medium slant, about thirty degrees with the vertical line, relatively plain and free from flourishes, and moderately rounded. These characteristics make for speed and quality in writing. Models for athletic performances may be difficult to secure, but efforts should be made to provide opportunities for children to observe expert performers in action, either directly or in good moving pictures. Coaches and playground directors should have sufficient skill in the games or sports they direct to demonstrate proper form. Models for shop skills may be supplied by taking children to see workers in action in their shops or on their jobs. (7)

The Control of Repetition or Practice

The Need of Practice

The waste that most learners make in the initial stages of perceptual-motor learning can be reduced to some extent by encouraging the pupils to study the relation of their own movements to the various elements in the total situation. This causes an increase of attention to the nature of the situation and stimulates efforts to respond correctly from the beginning. Despite efforts to eliminate waste of time and energy, and errors in performance, they can never be totally eliminated. The tendency of the individual to utilize ready-made responses in reacting to new situations, the inadequacy of this equipment, and the lack of functional conduction paths, all make for a large amount of diffusion and inhibition that have to be reduced through successive trials. Practice or drill is thus one of the most essential elements of sensori-motor learning. Practice of any kind is not

meant, but only practice under skillful guidance and conscious control. (5, 6, 7)

Nature of Repetition at Different Stages

On account of the persistent appearance of errors in this type of learning, the teacher should conceive of practice not as mere repetition of the same activity again and again, but as the repetition of an *effort* to perform in a desirable manner. *Learning is a reorganization of experience in the direction of successful performance, and this reorganization must go on during practice.* After learning has progressed to the point that successful performance is possible, then repetition of the same activity may be insisted upon. Until this stage is reached, the teacher should insist, (a) upon attentive repetition, and (b) upon trial or practice with the intention to improve. That is, the learner should be trained to keep his attention on what he is to do, and to attack each new trial with the intention of producing a more satisfactory response. Errors should be pointed out, but the child should not be made too anxious about them. He should be encouraged to avoid a particular error chiefly when it is in danger of becoming a fixed mode of response. In other words, the attention of the learner at first should be on the general outcome of the act; later, after some progress has been made, it should be on different parts of the performance. The reasons why attention should not be on errors, as a means of avoiding them, is that it increases the tendency to make them. In the case of persistent errors that are being acquired as fixed forms of responses, some degree of annoyance may be employed as a means of inducing learners to avoid them. (2)

Length of Practice Periods

The length of practice periods in acquiring skills is a question of much debate. Some teachers insist upon continuous practice for one or two hours, especially for athletics, music, typing, etc. "Practice," they insist, "makes perfect." But this is an old adage that has been used too freely without modification. Attentive practice for reasonable periods of time with a strong intention and a desire to improve is a more practical method. If practice is continued for too long a period, considerable fatigue is accumulated; and practice during such a condition of fatigue

is almost worse than useless. Thus, practice should not be so continuous or for so long a period of time as to bring on any considerable amount of fatigue. On the other hand, practice periods should not be too short. The learner should have sufficient time to get settled down to work and to make active efforts to improve. Usually from ten to fifteen minutes on most skills is sufficient for children in the first three or four grades, and from fifteen to thirty minutes in the upper elementary grades. Children beyond the elementary school are usually old enough to extend practice to forty minutes. But the practice during these periods should be varied sufficiently to make it interesting to the pupils. Practice periods which are short should not be scheduled too far apart, and especially not far enough apart for the learner to forget what he has learned.

Disuse is very effective, particularly in the early stages of learning. For small children two periods of practice per day, one in the morning and one in the afternoon; for older children one longer period per day is usually a sufficient amount. After a new activity is fairly well established, practice may be less frequent. Disuse seems to have little effect on well-established skills. It is desirable to continue practice, however, as long as one expects to have proficiency in the skill. That is, proficient and efficient performance requires a little exercise or practice at least three or four times each week. In the case of children, continuous practice from year to year allows time for physical growth to perfect the structures so that final mastery can take place. (7)

Fixation and Mastery

End Result

The end result of nearly all perceptual-motor learning should be a pattern of movement free of inhibitions, uncontrolled diffusion, and inaccuracy. The total movement should unfold in somewhat of a serial order without a high degree of attention to any of the stimulus elements, and it should go on in a more or less rhythmical fashion. In order to obtain such a result, a considerable amount of *overlearning* under the influence of *rhythmic stimulation may be employed.*

Overlearning

By "overlearning" is meant the effects of practice in performing a skill to improve it after it is acquired. The skillful musician, the typist, an expert penman, the golf player, etc., for example, is never satisfied with his present degree of achievement. He is found practicing from day to day further to perfect his skill or to avoid losing the degree of accomplishment already attained. Thus, this type of learning is not for initial accomplishment but for permanence of accurate performance. Such learning may include conscious efforts to eliminate persistent errors and to make the movements in the total pattern unfold in a free and rhythmical manner.

Uses and Values of Rhythm

The effectiveness of the kind of practice just described is enhanced by the use of rhythmic stimulation. By this is meant the addition of a rhythmic form of stimulation to the total learning situation for the purpose of securing smooth, unbroken, and accurate performance. The rhythm may be produced by counting, by a metronome, by playing simple march music on an instrument, or by striking a wooden or metallic object with a baton. The idea of producing rhythm in connection with learning is to induce the learners to perform the various parts of the pattern of movements in harmony with the different beats. The effects of it include: (a) the production in the learner of a feeling of smoothness in the activities; (b) the reduction of the amount of time to perform various movements; (c) more perfect control of the order of particular movements involved in a complex performance; (d) an increase in the speed of performance; (e) a lessening of the effects of fatigue; and (f) a relief of the learner from much of the monotony that usually accompanies drill. Not all performances, to be sure, are improved under rhythmic stimulation, but many, such as handwriting, typing, and playing musical instruments are improved to a very marked extent. Children who were drilled in writing and typing while simple march music was going on, for example, showed remarkable improvement as a result of this factor. Many forms of work have been known to be affected considerably toward increasing the output of employees through the playing of music. The negro

stevedore or cotton picker, in particular, seems to do his best when working in rhythm with his simple folk songs.

The use of rhythm in learning is most effective after some degree of skill has already been achieved. If it is introduced too early in the learning process, it has little useful effect and may add to the total amount of inhibition inherent in the learning. It is recommended here that it be used as a means of helping to perfect and fixate a pattern of action that is nearly or already acquired. (4, 7)

Effect of Emotional Factors in Forming a Skill

As a final word regarding the acquisition and fixation of a skill, caution should be observed against the danger of excessive emotional elements. The *somatic* responses that accompany sympathetic emotions are directly opposite to skillful behavior. Thus, the arousal of unpleasant feelings and emotions during practice greatly interferes with progress. Teachers should be careful, therefore, not to direct the learning of children in such a manner as to excite them or cause them to work under a strain. A child who is frightened, worried, or angered will rarely exhibit the skill of which he is capable when trying to learn under more favorable conditions. (9)

Characteristics of Progress

Perceptual-motor learning is usually such a long drawn-out process that it is important for the teacher to know its nature and characteristics at various stages. She should know, in particular, when to expect rapid or slow improvement, what is happening when improvement fails to result from practice, and what is happening when the learner reaches the final stages of proficiency or skillful performance. Many significant facts relating to this matter are revealed by a study of the course of improvement exhibited by learning curves.

Learning Curves

Learning curves, as suggested above, are constructed to exhibit progress, and all curves are constructed in essentially the same manner. The horizontal line on a sheet of graph paper is scaled to represent different amounts of practice, trials, periods of practice, tests, etc., and the vertical line is scaled to represent different degrees of efficiency, such as the amount of work done,

the number of seconds for each trial, the number of errors, etc. The curve is drawn through the points of intersection of the lines representing each of the measures. The direction a curve takes, whether it rises or falls from the beginning point, depends on the measures of progress which are used. A curve which

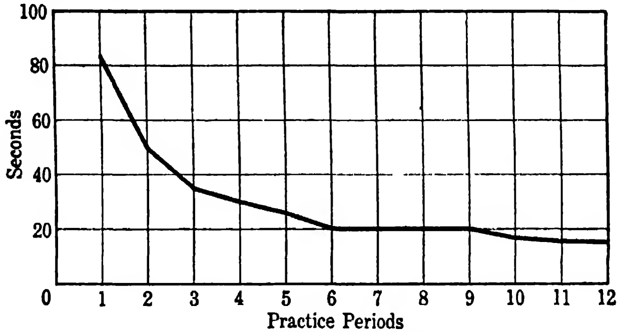

FIG. 29. Showing the time required to write 25 letters. A "falling" curve.

shows improvement in writing in terms of the amount of time required to write fifty words, for example, would start high and fall to a point lower on the scale; while one showing improvement in terms of the number of words written in five minutes for each of twenty trials would start low and rise to a point higher on the chart or scale. Thus, to symbolize progress we speak of a "rising" or a "falling" curve. The steepness of a curve signifies the general rate of progress. That is, if a curve runs in a horizontal direction, failing to rise, little progress was made, but if one runs in a vertical direction, making a sharp ascent, rapid progress was made in the learning activity. Whether progress is consistently regular or irregular can be determined by noting the relation of the curve to a straight diagonal line drawn (or imagined) from one corner of the graph to the other. Regular progress will result in a curve that tends to follow the diagonal, while irregular progress will result in a curve that will vary sharply from the diagonal. Regularity or irregularity of progress is also indicated in the smoothness or lack of smoothness in the curve. (10)

The Nature of Improvement

A study of curves exhibiting the rate of improvement in various functions shows that sensori-motor learning in general

appears to be relatively rapid in its initial stages, then progressively slower, and, on the higher levels, very slow. The curve of learning, therefore, rises or drops rapidly and then flattens out. The rapid rise in the curve is called the *initial spurt*, and seems to be a consistent characteristic of both animal and human learning curves. It appears to be a period during which motives are the strongest or when interest and effort are at their highest. It is also a period of orientation during which the learner masters the easier or grosser aspects of the situation. Although there may be numerous inhibitions at the beginning, the learner quickly overcomes these resistances and establishes modes of responses that more nearly conform to the general demands of the situation. As learning progresses, motives usually weaken, interests and effort wane, and the demands of the stimulus become more intricate. Thus, learning slows down and the curve gradually flattens out. (3, 7)

Plateaus

Frequently, though not invariably, learning appears to stop entirely before the learner reaches the level of desired proficiency. In such a case, the curve tends to flatten out at a level considerably below the expected level. Such periods as this are shown on the curve as *plateaus* or *critical stages*. They are called "plateaus" because of the shape of the curve, and "critical stages" because of conditions in the learner. The apparent failure to improve may not be real, however, for changes may be taking place in the nervous system that will later result in improved performances. For this reason, some psychologists have looked upon plateaus as necessary periods in learning, particularly in the acquisition of complex skills such as sending telegraph messages. Nevertheless, plateaus may be due to a number of other factors that it is possible to control, and therefore, they may be avoided or quickly eliminated. They may be due, in fact, to weakening motives or incentives; to a state of satisfaction in the learner resulting from the degree of accomplishment achieved; to incorrect form or to the failure to overcome persistent errors in performance; to a failure of the learner to observe the detailed nature of the situation; to continuous physical or emotional ailments; or to other similar conditions or factors. In other words, the learner may become

careless, inattentive, and indifferent to progress, and as a result he may fall into a habit of working or practicing lazily, failing to push himself on to higher levels of attainment. Even when the learner is aroused to vigorous effort to overcome a plateau, he may prolong it by neglecting to give proper attention to the details or factors to which it is due. Since plateaus may be due to factors that are more or less under control, their appearance in the learning of a particular child or class is an emphatic challenge to the teacher. She should try immediately to discover and make known to the child what his difficulties are, and in this way eliminate the plateau. She should never be satisfied with any degree of accomplishment the child has reached until he demonstrates final proficiency for his level of ability. If the teacher assumes this attitude, she may assist the learner in dealing with the special difficulties his special case presents, succeed in conquering every tendency to lag, and develop in the learner a habit of self-criticism that will prompt him toward vigorous and well-directed voluntary effort. (1, 3, 7)

Short-Time Fluctuations

Although the curve of learning should proceed in general toward a desired level of proficiency, many irregularities may be expected. Progress, in fact, is nearly always irregular, varying in amount from day to day, or from one period of practice

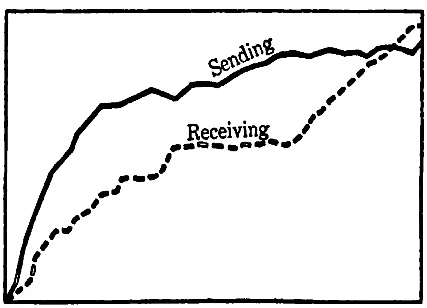

FIG. 30. Sending and receiving curves in telegraphy. (After Bryan and Harter.)

to another. This is because of the variety of conditions that affect learning. For one thing, a learner rarely ever feels the same from time to time; his interests, motives, and incentives

vary in strength; his physical condition fluctuates with proper or improper diet, sleep, exercise, rest, and general health; and his emotional attitudes are constantly undergoing changes. Besides, there are variations in the conditions of practice due to weather conditions, distractions by street or other noises, and various other temporary and unusual influences. Individuals apparently have good and bad days or periods during the learning period or period of work, for reasons that are difficult to determine. The curve of learning, therefore, is not a smooth curve; it exhibits many sharp rises and slumps or ups and downs that indicate the influence of one or many of the factors mentioned above. These rises and slumps in the curve that are due to temporary conditions within the learner, or conditions under which he is practicing, are called *short-time fluctuations.* These appear in the case of almost every learner who is acquiring any skill. They are, therefore, less serious than are plateaus; but again, the teacher should be mindful of them in order that a temporary condition might not result in a permanent habit of response or be extended into a plateau. (7)

Physiological Limit and Final Proficiency

If we disregard short-time fluctuations, the curve of learning should exhibit general improvement from the beginning of practice until final proficiency is reached. This last stage is reached when the individual can perform a given activity with a minimum number of errors and at a satisfactory rate of speed. It is, in fact, the best that one can do under ordinary working conditions for reasonable periods of time, without suffering from undue strain or from the harmful effects of fatigue. There is no set standard of proficiency, to be sure, but the teacher should encourage the learner to work toward the level of proficiency of which he is capable. This level is indicated by the individual's *physiological limit,* which is that degree of ability that the individual cannot surpass because of inherited limitations. The physiological limit is measured by testing the efficiency of the individual, after he has acquired the skill, for short periods of time during which he is especially motivated to do his best. One might, for instance, test the speed or quality or both of such functions as handwriting, typing, running, piano playing, and card-sorting, when the individual knows and

realizes that he is to do his best. If the measure obtained represents the very best the individual can do regardless of previous or additional efforts to improve, it is a measure or index of his physiological limit. In complex performances, such as those mentioned, however, the limit is rarely ever reached, for there is always a possibility of further improvement. But such measures as those suggested will indicate the highest degree of skill that the individual is capable of reaching. After determining the physiological limit or capacity of an individual, the teacher has an index of the level of proficiency that the pupil should maintain under ordinary working conditions. Most persons work too far below the level of their natural abilities, allowing themselves to move along at slow paces when habits of more lively movements need to be established. What is needed to speed up activity is greater motivation, and this is usually provided in upholding a standard of performance for each learner that approaches his natural limits. (7)

Norms of Achievement

The most practical standards for the teacher to use are those established through the use of standardized scales and tests. Such tests, it will be recalled, have been given to children of different ages and grades, and averages or norms have been obtained for these different ages and grades. These norms represent, therefore, what a normal child should be able to do under the best teaching conditions. According to the Ayres Handwriting Scale, for example, a child in Grade II should be able to write thirty-six words per minute, and his writing should show a quality of forty-four. Following are the norms for this and other grades.

Grade	II	III	IV	V	VI	VII	VIII
Speed	36	48	56	65	72	80	90
Quality	44	47	50	55	59	64	70

With such norms as these the teacher can indicate to her pupils what degree of proficiency they are expected to reach. Because of natural limitations some children, of course, will not be able to achieve average proficiency, but others, for the same reason, will be able to exceed it. A class as a whole, however, should ordinarily exhibit average achievement. If the

class fails to reach the standard, the teacher will do well to examine her methods and devices for assisting the pupils, and to examine her pupils to see if she has an average group.

The Social Aspects of Perceptual-Motor Learning

In a previous discussion on conditioning, attention was called to the social aspects of that simple type of learning. Attention should now be called to these aspects of perceptual-motor learning.

Social Character of Motivation

One of the chief social aspects in the acquisition of skills, as implied in a previous paragraph, is the process of motivation. It may be pointed out further that the child's approach to the acquisition of a skill is not mere expression of the native curiosity but a desire to do and be like other people. Fundamental to this desire, perhaps, is the universal tendency to imitate the performances of others, especially if the child perceives that those he observes are deriving pleasure and profit from the observed activity. The imitative tendency is expressed in a variety of ways, such as in the acquisition of language and in many forms of overt behavior; and it is likely the basis for what is called voluntary or purposive behavior. The most significant manifestations of this tendency, however, are expressions of interest by the child in the work and activities of others, and in his readiness to copy their performances. Let a young boy, for example, observe an older person using a hammer, saw, and axe; and then let the performer withdraw from the scene of action. No sooner is the field clear than the boy is doing his best to carry on the work. His activities are by no means skillful, but he works at the self-imposed task with an unmistakable earnestness.

The chief point in the foregoing illustration and discussion is that the child does not react to the *tools* of society in the way that he reacts to many other objects, or in the way that an animal reacts to the learning situations provided in the laboratory. For the child, the pattern of activity is frequently laid out in his observations of others, and his reactions are in all stages of performance guided to some extent by such conditions.

In order to direct the learning activities of children, the

teacher should become acquainted, to some extent, with the social nature of the stimuli she puts before them. She should, at least, realize that these have a social value and that the child should be made aware of it. Handwriting, for example, is a form of communication between individuals that has been painfully worked out in the past by social co-operation. In directing children the teacher should strive to make this aspect of their performance apparent to them. Perhaps the best approach to the problem is to create a social situation among the pupils themselves which will make for a type of co-operative effort.

Learning as Social Co-operation

From this standpoint, learning of any kind is by no means an individual matter—no more than the evolution of the tools of society has been an individual matter—it is, on the contrary, an acquisition dependent upon social co-operation. Suppose that a man highly endowed from the standpoint of native ability, such as intelligence and ability to learn, were suddenly placed alone in an environment of tools entirely new to him but capable of being used for his pleasure and profit. Without the help of other understanding creatures to master the use of these tools, his understanding of their purpose and use would remain to him much of a mystery. With others present to use them, the man would recognize their possibilities and values, and being stimulated would become an artist in applying them. There is, therefore, an important contribution that the teacher can make to the learning of children through acquainting them with the various possibilities and social values of the skills she expects them to acquire. (8)

EXERCISES

1. Describe three original examples of the type of perceptual-motor learning discussed in this chapter.
2. Compare the neural processes involved in acquiring a skill with those involved in conditioning. What are the chief differences?
3. Make a list of motives that a teacher might arouse in pupils to prompt them to learn to play the piano.
4. What are the characteristics of good models in the various skills?
5. Why is repetition needed in acquiring a skill? Make a list of suggestions a teacher should follow in her efforts to control the practice of pupils.

6. Criticize the adage: "Practice makes perfect."
7. Why is the use of rhythm somewhat ineffective in the early stages of learning?
8. Describe and indicate the significance of the following: (1) plateau, (2) short-time fluctuation, (3) physiological limit, and (4) final proficiency.
9. What are the principal social factors involved in the acquisition of a skill?
10. How might a teacher set up norms or standards of performance for pupils who are acquiring skill in (1) manual training, (2) tennis, and (3) piano?

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CHAPTER XIII

PERCEPTUAL LEARNING

INTRODUCTION

Purpose of the Chapter

Definitions

In the previous chapters considerable attention was given to the importance of training young children to pay attention, to observe, and to analyze the particular situations to which they are required to make motor adjustments. In this chapter, we shall deal with this aspect of learning in greater detail. Here we shall deal with perception not as a special preparation for motor responses, but as an end or goal of *perceptual learning.* This, in turn, will be considered as the process of acquiring the ability to recognize stimuli that directly affect the sense organs, such as concrete objects and spoken or written symbols. Here, indeed, we are to deal with a type of *cognition* or knowing, which may go on in the learner somewhat independently of motor adjustment, except when it appears as a product of them.

In other words, we are, in this chapter, approaching the study of *ideational learning* of which perceptual learning is a basic sub-type, the other types being conceptual, associative, and imaginative learning. In all of these, we are concerned with the problem of forming connections between mental rather than motor processes, which finally result in the cognition, apprehension, comprehension or understanding of a particular form of stimulation.

Specific Problems

The specific questions to which attention will be given in this chapter are: (a) How does perception begin? (b) How does it develop with age and experience? (c) What are the processes involved in perceptual learning? (d) How do the laws of learning operate in perceptual learning? (e) In what ways is this

type of learning involved in the mastery of particular school subjects?

The principal thoughts to be developed in the discussion of these questions are: (a) that perceptual learning is basic to all of the other types of ideational learning; (b) that all perceptual information originates with sensory stimulation; (c) that various combinations of sensory experiences result not only in perception but also in the ability to understand abstract ideas. (4)

EXAMPLES OF PERCEPTUAL LEARNING

As a means of making clear the nature of perceptual learning and as a basis for further observations concerning it, let us study some concrete examples. Let us note, first, the manner in which the child learns to perceive objects and then we shall study the way in which he learns to perceive language symbols.

An Example of Object Perception

Suppose we study the manner in which the baby learns to recognize his bottle. We shall discover that the process is very similar to that previously described as conditioning, except that mental rather than motor responses are dominant.

When the baby is first given the bottle, the following reactions probably take place:

S_1 (Nipple in mouth) ...... R_1 taste and tactual sensations and pleasantness
...... R_1' sucking movements

S_2 (Bottle in view) ...... R_2 attention and visual sensations (color and form of the bottle)

Since S_1 and S_2 occur contiguously, new connections tend to form between each S and the separate R's. Thus, if the combined stimuli are presented repeatedly, it is possible for the following type of reaction to occur when the bottle is seen:

S_2 (Bottle in view) .. R_2 (attention and visual sensations) plus R_1 (images of taste, tactual, and affective qualities) plus R_1' (sucking movements plus swallowing, etc.)

In other words, the sensations, feelings, and motor responses occasioned by the nipple in the mouth become attached to the

visual stimulus. When the visual stimulus recurs, therefore, these responses tend to recur apart from the direct stimulus. They cannot recur, however, as sensations; they have to appear in consciousness as *mental images* or as mental copies of the sensations previously experienced. Thus, in reacting directly to a given object, a learner may acquire a stock of sensory impressions that are capable of being aroused as images when the stimulus from which they are derived recurs. After varied experiences with the bottle, therefore, the baby can probably revive images of its color and form, of the taste of its contents, of its smoothness and hardness, and even of the pleasantness previously derived from taking food from it. Since all of these qualities are experienced in connection with the hunger drive, the baby may anticipate receiving the bottle when he sees it. This is probably why a baby makes rather positive responses to the bottle, reaching for it and cooing and gurgling when it is brought into view. At any rate, after reacting to its bottle in various ways over a period of time, every baby exhibits definite signs of perceiving it or of knowing what it is.

An Example of Word Perception

Suppose, as an example of word perception, that we wish to "teach" the child the "meaning" of the word "orange." How can he be made to recognize the word?

First, as suggested by the procedure indicated above, we may utter the word "orange" until the child appears to be attentive to the sound. Then we have:

S_1 (sound of word "orange") . R_1 (attention plus awareness of the sound quality)

Now the object may be presented to the eye and attention attracted to it by making the sound. Two stimuli are now operating:

S_1 (sound of word) . . R_1 (attention plus auditory sensations)
S_2 (round, yellow object) . . R_2 (attention plus visual sensations)

If the combined reactions are now repeated a number of times, and one or the other is presented later, the following types of reactions will probably occur:

S_1 (sound of word)..R_1 (attention plus auditory sensations) plus R_2 (visual images of the color and form)

and

S_2 (round, yellow object)..R_2 (attention plus visual sensations) plus R_1 (images of the sound qualities)

That is, if the connections are well formed in the original experiences with the two stimuli, the child will revive images of the visual qualities of the object upon hearing the word, and he will revive auditory images of the sound upon seeing the object. Furthermore, during this conditioning process, the child will probably make many other responses, such as reaching for the object, touching, handling, tasting, and smelling it. Whereupon, he receives a mass of additional sensations, such as tactual, kinaesthetic, gustatory, and olfactory, at or near the time the word is heard. Assuming that such is the case, and that connections form between the variety of experiences, we now have:

S_1 (sound of word)..R_1 (attention plus auditory sensations) plus R_2 (images of color and form) plus R_3 (images of kinaesthetic qualities derived from looking at, reaching for, and handling the object) plus R_4 (images of gustatory qualities) plus R_5 (images of olfactory qualities) plus R_n (images of other qualities derived from or in connection with the object)

This implies that the word-stimulus now tends to arouse any or all of the qualities derived from reacting to the object presented to the different receptors and from the movements which stimulate the kinaesthetic receptors. Any or all of these qualities, therefore, represent the "meaning" of the word "orange." It appears, at least, that the child employs some such procedure in building up percepts of various language stimuli. (8, 9)

PROCESSES INVOLVED IN PERCEPTUAL LEARNING

Mental Processes

From the foregoing examples and discussion of percept formation, we may infer the following phases, aspects, or separate processes: (a) An object is presented to various sense organs, together with any event that symbolizes it, at or near the same

time, and upon separate occasions. Upon the presentation of the stimuli, the learner becomes attentive to their various qualities, deriving therefrom a variety of sensory impressions, such as visual, auditory, tactual, kinaesthetic, and organic. These impressions, in turn, are registered in consciousness as memories. This constitutes the first process in the learning, which we shall call *impression* or *registration.* (b) Since these responses occur contiguously, upon successive stimulation of the different receptors, connections tend to form between the various qualities; so that the impressions are registered as potential images which can be aroused later as mental images or as memories of the initial stimuli. In other words, the contiguous occurrence of sensory experiences produces a synthesis, fusion, or combination, of one with another so that any one or all tend to arise in consciousness when any particular quality is rearoused by restimulation. This process of synthesizing, fusing, combining, or forming connections between sensations, images, or other mental events is known as *association.* This is, of course, a second and important process in perceptual learning. (c) All initial impressions and connections or associations can be aroused later because they are retained during a period of time. Impressions and associations may be made in reacting directly to a number of stimuli; but, as noted above, they can be aroused later. This is because of the factor of *retention.* (d) The arousal in consciousness of a synthesized group of past experiences by the recurrence of a particular stimulus constitutes the act of *recognition* or *perception* by which the individual *knows, understands,* or *comprehends* the stimulus. This, of course, is the goal of perceptual learning in so far as particular stimuli are concerned.

After the learner has acquired a number of particular percepts, or the habit of reacting to particular things by giving them an interpretation, he attempts to utilize these old percepts in reacting to new stimuli. That is, each new stimulus is interpreted, given meaning, or perceived in terms of old mental content. This aspect of perception is known as *apperception;* and the background of experience which the individual has at his disposal and with which he may be able to perceive a new stimulus is called the *apperceptive mass.* Since a learner develops a habit of responding to objects or events in terms of his past experiences, he tries to give meaning to all new stimuli whether

he can perceive them or not. When he is confronted with an entirely new stimulus the meaning of which does not readily arise, there is a tendency, desire, or craving to know what it means. This tendency is frequently called the *meaning tendency* of the mind. Each act of perception is, of course, a form of expression of the tendency, though we are not always aware of it. As a usual thing, perception takes place immediately upon the reception of a stimulus. (4, 5, 8, 9)

Physical Bases of Perceptual Learning

Neural Pathways

Like sensori- and perceptual-motor learning, perceptual learning involves the formation of connections among the neurons of the nervous system. In sensori- and perceptual-motor learning the connections formed furnish neural pathways over routes between the sense organs and the muscles and glands. In perceptual learning, on the other hand, the connections formed furnish pathways between the receptors and the various centers of the cerebral cortex. The formation of such connections makes it possible for a chain of neural activity initiated by a sensory activity to go on, and this may involve the successive arousal of the different centers connected. For example, when one stimulus impinges upon the receptors of the eye and another upon the ear, at or near the same time, functional connections may form between the visual center in the occipital lobe and the auditory center in the temporal lobe. Thus, if either stimulus recurs, and one center is rearoused, the other will be rearoused also. Assuming, then, that combinations of stimuli occur, each center of the cortex is connected with all other centers. In this manner a single stimulus may arouse a group of impulses that are not only discharged from the receptors stimulated to their cortical center but are discharged also to all other centers that have been connected with each other. (8)

Conscious and Neural Correlates

While this activity is going on, there may arise in consciousness a succession of sensations, images, and memories by which the sensory qualities of any particular stimulus are given an interpretation. Suppose the stimulus that impinges upon the

eye is an apple and the one on the ear is the word "apple," and that later the word "apple" is presented. In this case, the impulse proceeds from the ear to the temporal lobe to produce the sound of the word, and from here over the connections formed by contiguous stimulation to the visual area to produce visual images of the apple. If other stimuli have occurred in connection with either of these, the centers previously aroused tend to be rearoused also and to occasion additional images or memories by which the stimulus now present to the senses is given further interpretation. In brief, when a stimulus acts upon a sense organ, a group of nerve impulses is aroused and discharged into a definite center of the cortex. Here the impulses spread or diffuse to other centers and reactivate neurons previously active in connection with the stimulus. As these neurons are aroused, there arises the meaning tendency and the act of recognition in terms of the individual's background of experience.

Each of the mental processes described above has its physiological correlates. The word "impression," for instance, carries with it the implication of "stamping in" or modifying the nerve structure. "Association" implies forming connections between the neurons of different centers; and "retention" has reference to preserving the impressions and modifications. This latter factor depends, of course, upon the plasticity of the nerve structure and the depth of the impressions. The total or partial revival of images and memories of a past experience depends also on the depth of the impressions, the strength, and complexity of the connections, and upon the individual's native capacity to retain. The process of "apperception" is a conscious accompaniment of the tendency of all retained impressions to be revived when a sense organ is restimulated by a quality to which the individual has reacted in the past.

All mental processes appear to be correlated with, and even occasioned by, cortical activity; and the factors that influence one influence the other also. Thus, it is probable that in the myriads of possible connections which may be formed in the cortex, we find the physiological basis for the myriads of mental states and processes that appear to be associated. At any rate, physical and mental processes go on at the same time, and are so interrelated that the former are thought to be causes of the latter. In describing mental processes, many psychologists, as a

rule, speak of connections between sensations, between sensations and images, between images and ideas, and the like, as existing in the "mind." What appears more likely, however, is that connections are formed between brain structures and that these are responsible for the apparent connections between sensory qualities, images, ideas, etc. Mental elements, in fact, have nothing about them that could make them adhere or associate, but nerve structure can be modified by stimulation and one neuron can be functionally connected with another so that they function as one or in succession. (12)

DEVELOPMENT OF PERCEPTION

Character of Development

Perception develops in three ways: first, through the accumulation of sensory experiences in regard to particular objects; second, through reacting to many different objects; and third, through reacting in specialized ways to particular things. The first two processes begin with the absence of perception in infancy and proceed toward the ability to perceive many different things, and the third process is brought about by special drill and training usually given in school. A brief discussion of each type of development will make clearer the processes described above and suggest many problems with which educators are confronted.

Bases of Perception

The Learning Process of Infants

The beginnings of perception appear to be the sensory experiences secured in the first months of life. The first mental experiences of infants appear to be sheer sensory qualities void of meaning of any kind. There are no signs of perception in infants; only evidences of their capability of sensing different qualities and of giving attention to the most vivid or intense form of stimulation, such as nursing, sleeping, awaking, exercising, and playing at certain times of the day. The infant also exhibits annoyance when the routine of treatment which occasions these habits is disturbed. This is particularly the case if the infant is protected from such severities as abrupt changes in

temperature, shocks, diseases, accidents, and malnutrition. From the standpoint of perception, however, this is only a "period of impressions" during which the infant passively receives impressions of what he sees, hears, tastes, smells, and from what touches him and from what goes on in his viscera. In receiving such, the cortex becomes the medium by which impressions are registered and retained. Day by day, the young child's attention fluctuates from one object to another, according to the vividness or striking quality of each; so that impressions are made by many objects and from the same objects that constantly recur. In this way, the infant seems to acquire a background of impressions which can be utilized later in the process of knowing. (8)

Beginnings of Perception

While the habits of infants are but gross instances of motor conditioning, the impressions made during the conditioning process soon expand into signs of recognition. The normal child is not over two months old when he begins to show signs of preferring his mother to other persons, and by six months he shows definite signs of recognizing her features and voice. The baby pays attention to many things, in fact, and begins to respond to them in knowing ways. For instance, he knows his bottle, his favorite toy, his father, and numerous other objects that please or annoy him, and he exhibits such knowledge by making positive responses to some objects and negative ones to others.

At about ten months of age, the baby reveals signs of giving prolonged attention to particular objects, during which he appears to be examining them somewhat critically. For instance, the baby will look at a piece of paper, reach toward it, manipulate it, listen to the crackle or tear, and so on, for extended periods of time. He also examines his toys, the faces of persons, strange objects that appear, etc. It is during these periods of attention, as we have seen, that the baby is easily conditioned to respond to particular objects and even to their separate qualities, a type of learning that is not possible earlier. Whereas the infant merely looks at or listens to unusual stimuli, and adjusts to general situations only, such as those afforded by routine treatment, the year-old baby looks, listens, and responds in fairly definite ways to particular things and their qualities.

In such performances as these, the baby shows that he knows, to some extent, what things are. (13)

Development of Object and Language Perception

"Motor Meanings"

From babyhood, children busy themselves in making adjustments to many different objects. The child still pays attention to intense or unusual forms of stimulation, but he is also attracted to any object from which he derives pleasure or displeasure; and these are the objects that he can manipulate or play with and objects which he knows he must avoid in order to escape pain, fear, or annoyance. When they occur contiguously with various tendencies, external objects become connected without the tendencies being present. When this happens, the objects have power to attract attention and effect adjustments. Thus, the child begins to deal with objects as things in themselves which have definite meanings. The meanings, at first, are in the form of image patterns arising from previous reactions made to them, and these patterns appear to be composed chiefly of images derived from strong sensory experiences, such as feelings, emotions, and tendencies, and from habitual motor responses. As soon as objects acquire the power of eliciting this type of meaning, the child's behavior is no longer semi-automatic, but highly self-directed. That is, children show a disposition to deal with objects in order to achieve various ends or goals. In other words, through receiving impressions, and making associations between different qualities of objects, images, and motor responses, the child acquires an apperceptive mass by which he is not only able to perceive particular objects, but which also furnishes the possibility of making varied responses to them. Thus, when a particular object is presented, he does with it whatever he *voluntarily* chooses to do with it. (13)

Language Meaning

While the child is acquiring the ability to deal with objects in various ways, he is also engaged in attaching to them various language stimuli. These stimuli consist of words, sentences, phrases, exclamations, and other vocal products presented in connection with objects by persons associated with the child.

Because of the known limitations of the child, the language stimuli most frequently presented are single words which name or symbolize the different qualities of objects. Since these occur contiguously with almost every object, the child soon acquires a stock of *verbal images* to add to his concrete images as a part of his apperceptive mass. By this means the child is able to perceive objects as things which are called by different names. Furthermore, he also, by the same processes, perceives words as symbols of particular objects. Whereas the meaning of an object may be at first the image content of sensory qualities, affective states, and muscular responses, the association of words with objects finally results in the dominance of verbal images. Verbal images, in turn, become associated with each other; so that ability to *think* about an object in terms of language responses or symbols is possible. Furthermore, each word or other vocal expression which is at first associated with only a single object is soon associated with other objects and with other words; so that the individual develops the ability to think of particular words not only in terms of objects, but also in terms of other words and the experiences which they symbolize.

There is hardly an end to the meaning that may be attached to a particular object or to a particular word. The sight of a dog, for instance, may elicit a variety of tendencies, play responses, the dog's name, and even ideas about other dogs. The word "dog" may mean to a child his pet and other dogs that he has seen, and to the adult many different kinds, sizes, colors, and descriptions of dogs. This type of meaning, however, is known as a *concept;* its nature and the types of learning involved in producing it will be discussed later in a chapter on conceptual learning. Perception has taken place when the individual is able to name a given object or point to a particular object when he hears its name, or to demonstrate in any way that he knows what a thing is.

The development of ability to understand spoken words seems to take place in somewhat the following order: (a) The infant is aware of language merely as a jargon of sounds. (b) Through a process of conditioning, words and sentences are substituted as stimuli for objects and situations which call out motor activities, and which also arouse images of object qualities, emo-

tions, tendencies, and previous motor responses. (c) Words become substitutes for action and can be manipulated in thought without being expressed in action. (d) Understanding continues to expand toward varied and complex forms of generalization and abstraction. Most of these stages will be discussed later. (13)

Perception of Object Qualities

Specific

One of the most common types of perceptual learning observed in young children is that resulting in recognition of object qualities, such as color, form, size, weight, roughness, etc. These may be understood either as percepts or concepts. A percept of color, say "red," is knowing its name and being able to identify it in a particular object; a concept of "red," on the other hand, is knowing the color in the abstract sense, as a quality belonging to numerous objects not in the field of perception. The percept of color, and of any other quality develops ahead of the concept.

The most elementary forms of this type of perception are observed in the child's attachment of particular qualities to one or more objects. "Blue," for example, belongs to the little girl's pretty dress; "two" refers to the fingers; "heavy" is associated only with the electric iron. In this form, the qualities possess little thought significance, except that they appear as parts or details of whole patterns; but when the child begins to react to them as things in themselves, to identify a given quality in a variety of objects, they constitute elements by which one object is differentiated from another. In other words, the child gradually acquires the ability to distinguish between objects in terms of differences exhibited by their distinctive qualities, instead of having to depend upon general or superficial impressions. This is particularly the case when the qualities can be symbolized by the words that represent them. (8)

Perception of Size

Among the slowest forms of perception to develop are those of *size* and *distance*. The reason for this is that the perception of

either depends on a number of sensory qualities or "cues" that have to be interpreted in a variety of changing patterns.

Size is the awareness of the bigness or extent of a given object. This awareness or impression is produced mainly through the visual and tactual senses, but it is contributed to by various other senses. It depends, first of all, on the size of the area of the retina or of the skin stimulated by an object. If an object is near the eye, it stimulates a larger area of the retina than when it is far away. If two objects of unequal size are the same distance from the eye, the larger object stimulates a greater area of the retina than the smaller object. This is one of the sensory cues, therefore, by which we sense the size of a given object or by which we are able to compare the size of one object with that of another. At the time these visual impressions are being received, the child is also receiving tactual and kinaesthetic sensations. Tactual sensations are received in the process of touching and handling objects. Large objects stimulate large areas of the skin; smaller objects stimulate smaller areas. These impressions are received at the same time with the visual sensations and combine with them to produce a background for the perception of size. But the kinaesthetic sensations derived from looking at and handling objects are perhaps more important than these. The kinaesthetic sensations received from looking at an object come from the muscles involved in moving the eyes. When we look at an object, our eyes do not remain still, but they move about from one part of the object to another. These movements stimulate receptors in the muscles of the eyes and produce sensations from that source. The amount of movement necessary to examine a large object near the individual is greater, of course, than the amount necessary to examine a small object at the same distance. As the child experiences these impressions, he combines them with the visual and tactual cues suggested above.

The importance of kinaesthetic sensations from the muscles of the eyes may be illustrated by a study of certain illusions. An illusion is a normal false percept; a false percept experienced by each person as a result of the nature of the stimulus. In the accompanying figure, is reproduced the Müller-Lyer Illusion. Observe that the two lines between the oblique lines attached to each appear to be different in length; that is, the line in A

appears to be longer than the line in B. This is due, in part, to the difference in the amount of eye movements stimulated by the two figures. In looking at the whole of A, for example, one will move his eyes farther than he will move them in looking at the whole of B. As he does so, he is thinking which is the longer. The kinaesthetic sensations occasioned by greater movement for A are interpreted with regard to the line. Thus, the individual perceives the line in A as being longer than the

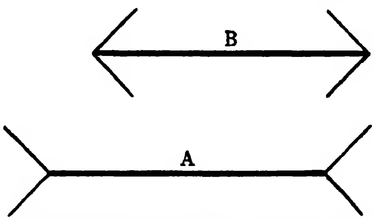

FIG. 31. The Müller-Lyer Illusion. Is line A or B longer?

line in B. A greater amount of practice in judging lines in this setting will result in the gradual elimination of the illusion.

Many other kinaesthetic sensations are received from objects in the process of handling them. These come from the muscles of the fingers, wrists, arms, and gross bodily movements. The weight of a given object, for example, is sensed as the amount of pull or strain on the muscles involved in lifting it. Since large objects are usually heavier than small ones, these sensations are important cues for size. Pressure sensations also contribute to weight, in that heavy objects require greater pressure to lift them than do light objects.

After receiving all of the different types of sensations suggested above, contiguously and in various combinations, the individual is prepared to image any one quality or group of qualities when stimulated by the object through any given sense. If the child has seen, handled, and lifted a given object, in other words, he is prepared to revive the images of these experiences merely upon seeing it. While the child is being prepared to image the sensory qualities in the manner suggested, he is receiving auditory stimulation from words, such as "large," "small," "big," and "little," which stand for these qualities. Thus he gradually arrives at the ability to perceive size and to describe it by the use of words. (20)

Distance Perception

The perception of *distance* takes place when we realize or know that an object is near to or far from us. This type of perception, like that of size, depends upon a variety of sensory experiences. These come mainly from the eyes in the form of visual and kinaesthetic sensations, but there are other kinaesthetic sensations from the muscles involved in moving about among objects. In looking at an object with both eyes, we can see both sides as well as the front, unless the object is too large, and this sight of sides and front simultaneously helps us to perceive distance. Usually various objects come between the eyes and a given object. This situation enables one to see that the intervening objects cut off parts of the more distant object. Moreover, objects near the individual stand out clearer in detail than distant objects, particularly in structure, color, and definiteness. These are all important cues in the perception of distance. In order to keep an approaching object in clear focus, it is necessary to converge the eyes. That is, the eyes turn inward toward the nose, producing a mild strain on the muscles. These movements and strains being sensed give the impression of distance, for objects near us cause the eyes to converge more than objects at a greater distance from us. In order to keep an object in clear focus as it approaches, it is also necessary for the lenses to bulge or thicken, and this movement arouses other impulses and sensations. We move about among objects, approaching them and drawing away from them, and in this way receive impressions of various kinds. All of these sensations gradually combine or integrate so that one reacts to objects as being near or at a distance from him. (20) He may do this, of course, without being aware that he is utilizing all of his past experiences in a moment of time. Upon receiving a cue of distance, however, one can supply the images necessary to react in terms of his total past experiences. When these experiences become connected with words such as "near," "far," "long way," and the like, the words themselves become substitute stimuli for the revival of the mass of images necessary to understand them. Gradually these understandings are translated into symbolic form in acquainting the child with standard units of measure, such as the inch, foot, yard, and mile. He

becomes able to perceive these symbols when his experiences are sufficiently varied to give them meaning. (20)

Children's Reactions to Unknown Stimuli

Accurate Perception

There is only one way of knowing objects and events in the sense of accurate perception, and that is to perceive them in terms of past experiences. This, as we have tried to show, is the manner in which accurate and adequate percepts arise. We have tried to indicate also that the experiences that contribute most richly to percepts are those most directly associated with their stimuli. When this type of association is made to occur, accurate and adequate perception is not difficult to bring about. (4)

Apperception

There is a tendency in all persons, however, to interpret a new stimulus in terms of past experiences whether such experiences have been previously related to it or not. For instance, what is the object in Fig. 32? This is the *meaning tendency* previously described, and the interpretation of the new in terms of old mental activity when it is employed in connection with a careful analysis of the stimulus and a careful selection of past experiences; but when it is employed by children, it usually results in very hazy, indefinite, inaccurate, and even grossly false percepts.

FIG. 32. What is this?

This result is due, largely to two characteristics of mental activity in children: (a) as we have indicated in a number of instances, children are superficial observers; they react to objects and situations from most general impressions without attempting to study or analyze them; (b) children, as a rule, have too limited apperceptive masses to perceive in this way. (7)

G. Stanley Hall, in a classical study of the content of children's minds, discovered a number of facts which sustain the points made above. He found that children not only have hazy and indefinite percepts of common things but that they also

exhibit gross ignorance of words most commonly used, and that these words symbolize objects and events a knowledge of which many teachers had taken for granted. For example, in a Boston school, 53 per cent of the children had never seen a sunset; 30 per cent had never seen clouds; and 50 per cent were ignorant of the sources of things made of wood. On the basis of many such findings, Hall made the striking statement: "There is next to nothing of any pedagogic value in the minds of children when they start to school." This discovery implies that the teacher must supply an apperceptive mass for each object or symbol before she can be certain that the child comprehends it. It is hazardous to take any knowledge for granted when children are being taught new things. (7)

Development of New Meanings

This does not mean that the teacher should ignore the past experiences of children in teaching new things. As a matter of fact, she should attempt to discover what these experiences are, try to correct them when they are found to be faulty, and then to help the children relate those that are applicable to each new stimulus. This procedure will assist in the development of meanings of new things in terms of past experiences, and this is a desirable outcome of all teaching. Meanings arise, as we shall indicate later, mainly through calling attention to certain relations and helping learners symbolize these relations in language. This results in the formation of concepts or general understandings which, in turn, strengthen percepts of particular things.

THE OUTCOME OF PERCEPTUAL LEARNING

Quick and Accurate Recognition

The end, goal, or outcome of perceptual learning is not specifically the ability to think about a particular object, word, or other stimulus, but to recognize a stimulus quickly and accurately. That is, the act of recognition should follow directly the reception of the stimulus, with as little loss of time as possible; and the meaning or understanding should be adequate enough to meet the learner's needs at his particular stage in life. The act, indeed, usually consists of a quick analysis of the stimulus pattern and a revival of that part of one's apperceptive

mass by which it is given a correct interpretation. For example, when the child sees the word "pear," he must recognize it immediately as a word meaning a particular species of fruit; he must not confuse it with "pair," "pare," "spear," or with any other word. Similarly, when the child hears a noise, he should not recognize it as a "bogy man" or a policeman coming to get him, but possibly as the postman delivering the mail.

It would appear, then, that training in perception should consist largely in presenting objects or other stimuli and telling children what they are, and in drilling the children in giving this particular response. While much perceptual learning may go on as a result of this simple procedure, this type of training will not contribute greatly to essential perceptual development. The main problem in perceptual training is to help the child acquire a background of experience from which he may select appropriate responses. A child of six months or a year of age, for example, sees nothing in a picture exhibited to him except blotches of color; while the child of three recognizes the picture as that of a dog. In order to recognize such a stimulus, the child must have had considerable experience in reacting to such details as colors, shades, forms, etc., on many different occasions. Thus, in addition to providing drill in reacting to particular stimuli, the teacher should seek to enlarge or expand understandings of them and of things related to them, and to correct hazy and inaccurate notions which pupils try to relate to particular stimuli. (4)

Unitary Character of Adult Perception

The quickness with which the adult perceives familiar objects makes perception appear a much simpler process than it has been represented above. If one now sees an apple, for example, he is not only aware of the redness and roundness of the object as visual sensations, but also, perhaps, of its sweetness, pleasant odor, uniform pulp, smoothness, and other qualities, as mental images. All of this mental content, or whatever mental content he may have, does not arise as independent, successive events, as we have been compelled to name those here; but it arises as a single, unitary whole, almost impossible to analyze. The present and past seem to fuse in consciousness and to produce the percept as a single product of consciousness.

If an adult is confronted with a new stimulus to which he cannot react, he experiences a kind of mental void that prompts him to inspect the stimulus carefully, study it in the light of similar forms of stimulation received in the past, and seek new information about it. This is a type of activity in which the child should eventually learn to engage. (3)

MEASURES OF PERCEPTION

Reaction Time

The quickness of perception is usually determined by measuring the amount of time elapsing between the appearance of a stimulus and the individual's response to it. This time interval is usually called "reaction time." It is used by psychologists to study the readiness with which individuals perceive many types of stimuli, to discover individual differences, to secure data which will reveal the growth and development of the function, and to discover the senses through which stimuli are perceived most quickly. Such studies are of general interest to teachers in that they throw considerable light on the nature of perception. In practical situations, however, the teacher will not have opportunity to employ the complicated apparatus used by the psychologist in getting such measures, but she can devise many measures of her own. In reading, for example, the teacher might give each child a list of words to pronounce and note the time required to complete the list. This type of test will yield a rough measure of reaction time and indicate those words with which the pupil has difficulty. Similar measures may be made of reactions to object stimuli.

Some facts regarding reaction time measures may be mentioned in passing: (a) Usually tactual is quicker than auditory and auditory is quicker than visual reaction time. (b) Reaction time decreases with age and experience. That is, as children grow older, they can respond more quickly. This decrease in reaction time is a function both of maturation and learning. Children of age three, for example, cannot respond as quickly as can children of age six, regardless of the amount of training each group has received. (c) Children of any age, moreover, respond most quickly to stimuli with which they are most familiar. All of these facts, of course, have special significance to the teacher. (3)

Span of Perception

Another measure of perception is called the "span of perception." This is measured by exhibiting a number of objects in a series or group, such as objects, letters, words, numbers, etc., for about 1/5 to 1/25 of a second, and determining the number the individual can recall and relate, that is, give orally or in writing. This type of measure not only reveals the readiness of the individual to respond to the types of stimuli employed but also, to some extent, the ability of the individual to synthesize details. Studies in which the measure has been employed indicate that from three to five items is the average range of perception in adults and from two to three is that of children. The measure varies, however, with individuals as well as with age, and particularly with the degree of familiarity of the subjects with the stimuli and with the manner in which they are grouped. If letters are used, for example, a greater number can be perceived when they are presented in discrete series, or as separate items and not arranged in words. This implies that individuals attempt to perceive entire groups of items as wholes, or as being related in some way. When the relations have been observed previously, an unusually large number of details can be perceived in a single act of consciousness. A person with a wide span of perception can perceive several words, for example, in a fleeting glimpse of a line of print. This ability to react to details in objects or situations as belonging in a group results in a habit of building up percepts by proceeding from the whole to the part, and this becomes a very useful tendency in the formation of new percepts. This procedure is followed, however, only by persons who have some degree of familiarity with the whole at the start. Otherwise, perception may begin with acquaintance with parts and proceed toward relating the parts to the whole in which they appear. (20)

The quickness and accuracy of perception in regard to various types of stimuli are frequently significant measures of native functions and are indicative of probable success in various lines of work. A person who is definitely slow in recognizing words, for example, would probably fail to make an expert stenographer. Too, a person who is typically slow in reacting to

sounds, such as the dashes and dots used in telegraphy, would find it difficult, if not impossible, to become a telegraph operator. This is true in either case, or in other similar cases, because training and practice are not the only factors involved in this function. These factors result in improvement up to the individual's physiological limit. Beyond this, the limit of his native capacity to learn, training and practice fail to improve the function. In training children to perceive, therefore, their native capacities are goals or limits toward which improvement should be directed. (22)

PRINCIPLES OF PERCEPTION

The foregoing discussion of the nature and development of perception in young children is intended to serve as a background for the study of certain principles of perception. By "principles" is meant the laws, facts, and rules that should govern teachers in assisting the child to get acquainted with a given concrete object or symbol. Much of the learning described above goes on without a teacher. It is, in fact, a more or less haphazard type of acquisition. The learning that goes on in the school should be definitely determined by the teacher. In order to indicate what she may do to insure the best results, as far as perceptual learning is concerned, we propose the following principles suggested by the laws of learning. Later we shall indicate some of the principles of learning as they are exhibited in the acquisition of particular school subjects.

Law of Readiness

There are four ways in which the *law of readiness* may be applied to perceptual learning. These are: (a) readiness in the sense of physiological efficiency; (b) readiness in the sense of motive, urge, or tendency; (c) readiness in the sense of apperceptive mass; and (d) readiness in the form of "mental set" or expectancy. Some discussion will make each of these clear.

Physiological Efficiency

Since all perception depends first upon bodily structures, the teacher should see that the child is physically ready to respond to new things. She should, in particular, give attention to sensory defects. Defective vision or hearing will result in inade-

quate percepts in a large number of instances. Defective vision, it may be pointed out, often results in inability to respond to the details of objects. As a result the learner often fails to become aware of the real nature of things, such as their colors, structure, and forms. In reading, the child tends to confuse similar letters and words, and thus to mispronounce and fail to get the correct meaning. Moreover, his visual images will be too hazy and indefinite to be of much practical value in interpreting given objects. Defective hearing is especially harmful in the acquisition of spoken language. The hard-of-hearing child, in fact, is especially backward in learning words which are similar in sound, such as structual words, prepositions, and conjunctions, and various other words that fail to receive emphasis in oral speech. Physical readiness may also involve a healthy body. The first task of the teacher in all school work is to see that the child is in the proper physical condition to learn. (7)

Motivation

Readiness in the sense of motive, urge, tendency, or desire to learn is a most significant factor. The objects that a teacher selects as being most significant for the child to know may not appear to be significant to the child. Thus, another task of the teacher is that of getting the learner in a receptive state; to induce in him a desire to know the objects and to react vigorously toward each separate stimulus. In order to do this, the teacher may resort to an appeal to particular instinctive or acquired tendencies. She may also labor to make the knowledge she wants the child to acquire to have some practical value for him, remembering that what appears of practical value to her may not appear so to the child. The desire to know is of fundamental importance in all learning. (2)

Apperceptive Mass

Readiness from the standpoint of apperceptive mass is a matter of importance in that children are not equally prepared to respond to different types of stimuli. Some pupils, as suggested above, may have little and some much information; others may have correct and still others false impressions; some pupils may come from rural and others from urban communi-

ties. Thus, it is good practice on the part of the teacher to ask questions, quiz, or examine the children in one way or another in order to discover at the outset just what their stock of percepts is. Such information will serve as a basis for further procedure in knowing what information to supply, in correcting false impressions where they exist, and in linking new information with that already in the minds of the learners. When the teacher has no way of discovering the children's ideas of particular things, she should proceed on the assumption that they know nothing at all. A procedure of this kind insures that each child, however ignorant or well informed, will get something from the discussion. One of the beginning teacher's most frequent failures is that of not understanding the content of children's minds sufficiently to get on common ground with the children. Most teachers just starting out "shoot over the heads" of the pupils.

Mental Set

The term "mental set" is used to describe the present or passing content of the mind of the learner, such as when he is in a state of expectancy. This state of mind is so important in determining what and how a person perceives that it is imperative to give attention to its effect. Regardless of the nature of the sensory stimulus, the adult and child alike usually perceives what he expects to perceive. For example, if one unknowingly puts salt in his coffee instead of sugar, there will likely be a lapse of time after he drinks the mixture before he becomes aware of the saltiness. The child about to be punished is hurt long before the whipping starts, or one who is watching for the approach of a friend in a crowd may "see" him a number of times before he actually arrives. These examples mean that when any one expects to sense, feel, or perceive any certain thing, those are the things of which he becomes aware. It is obvious, therefore, that the state of expectancy or mental set may determine whether the resulting percept is true or false, and in many instances whether it is adequate or inadequate. (15)

The factor suggests that the teacher should prepare the child's mind to react to given stimuli. This may be done by previous discussion of an object that has not been exhibited. It may be accomplished, too, by giving the children a list of

questions regarding details that should be observed, or by describing the object or symbol before it is presented. The point is, if the learner is assisted in keeping in mind the aim of the work, if he knows definitely what he is to do to achieve worthwhile results, or what he is to look for in making an observation, he will react to things in a manner that will insure some degree of learning of the desired kind. A failure on the part of the teacher to prepare the minds of children in some such manner may result in false and undesirable percepts, and in confusion and waste of time. (15)

Law of Repetition

The *laws of use, disuse, frequency, and recency* function in perceptual learning in very much the same way that they do in conditioning. That is, the learner comes to know a given object or symbol by reacting to it again and again, and he tends to forget things that are not presented frequently. It is important, therefore, that pupils be given sufficient drill in reacting to particular objects to insure deep and lasting impressions. In order to avoid the effects of disuse, in particular, the stimulus should be repeated at various intervals over a long period of time. Drill or practice or study should not be long enough to produce boredom or distaste; the periods should be relatively short and the study intensive. The value of repetition is that it deepens impressions and makes for clear and definite images. For example, one can always image those things that he has reacted to a number of times better than he can image those things to which he has reacted only a few times. We should, therefore, give the child an opportunity to react frequently. (7)

Law of Contiguous Stimulation

In the previous description of the nature and development of perception, reference has been made frequently to the principle of contiguous stimulation in the formation of percepts. It is obvious that this is the most essential condition for perceptual learning. It is necessary to experience the various sensory qualities of an object at or near the same time in order to establish the neural connections necessary for one quality to revive the image of another. It is by this principle also that details in objects are related to the whole and that different

objects or images become associated with one another. Moreover, by reacting to the various qualities of objects and to language stimuli at the same time, the process of substituting words or symbols for objects and their qualities goes on.

When it is translated into a principle of guidance for the teacher to follow, this law suggests that objects and symbols should be presented to the learner through as many different sense avenues as possible. Such a procedure gives the learner a rich background of sensory experience for each stimulus, and this is a necessary preparation for adequate perception. Thus the child should see, hear, taste, smell, handle, or touch the objects he needs to know best. When the stimulus is a symbol of a concrete object, the symbol and the object should be presented together, especially in the case of beginning pupils. It is of advantage, for example, in beginning reading to present words along with pictures or actual objects. Many teachers label the familiar objects in the classroom with printed words as a means of accomplishing this result. In building up percepts of abstract qualities, the quality should be presented contiguously with or as a quality of many different objects and classes of objects. In brief, have the pupils look at, listen to, touch, lift, manipulate, and even smell and taste, the objects they need to know. (7, 10)

Law of Attention

Since attention is the first act of adjustment to any stimulus to which an individual consciously adjusts, it is very closely related to perception. We might say, in fact, that attention is a necessary condition for perception to occur and especially for a percept to be formed. It is desirable, therefore, that the teacher (a) strive to make objects attract attention; and (b) induce the pupils to give to them sustained or active attention.

Types of Attention

The first type of attention, it will be recalled, is known as passive, free, or *involuntary attention.* This type depends upon the striking qualities of the stimulus and the way in which the stimulus affects the one attending. Any object will attract attention, for example, if it is intense, if it arouses vivid sensations, if it moves, if it contrasts with others presented in con-

nection with it, or if it arouses a pleasant or an unpleasant state. What the teacher needs to do to attract attention, therefore, is to present objects to pupils so that the objects will exhibit some one or all of these qualities. In order to do this, she can make use of color in various ways, underscore special items, use a pointer, move an object about, arouse feelings and emotions, and make the object fit into the experience of the learner. Sustained, active, forced, or *voluntary attention* is secured largely by arousing strong motives through the use of incentives. As incentives to attention, the teacher may arouse instinctive or acquired tendencies, make objects and information about them appear to have practical value to the learner, cultivate definite interests, and stimulate desire to imitate particular models, such as those in drawing. The motivation of the child to secure his attention is a task that is always present. (1)

Fluctuations of Attention in Perception

The importance of attention in forming percepts may be further emphasized by reference to the fluctuating character of attention. When one first attends to an object, he seems to give it a superficial inspection, noticing the general outline and one or a very few striking details. This preliminary response is intended apparently to determine whether the object has particular value as a satisfier of a tendency. If there is nothing about it to challenge further adjustment, attention may change to another object, then to another, and so on and on. This type of attention is characteristic of all small children. They attend to many different things in a short period of time. Their attention is thus said to fluctuate from one object to another. This fluctuating character of attention has the advantage of making children aware of a large number and variety of objects, but it has the disadvantage of making them aware of different objects in a superficial way. Thus there is the necessity of bringing the child to prolong or to concentrate his attention upon particular objects. When we do this, the natural fluctuations that seem to characterize attention are not stopped, but they are restrained, and limited to a particular object. When it is limited to a particular object, attention fluctuates from one part of it to another. This is especially the case when objects

are presented through the senses of sight and touch, and when stimulation can be prolonged. When objects or symbols are presented through the sense of hearing, the teacher has to rely mainly upon a mental set. Sounds, especially language stimuli, have a way of lasting for only a short period of time, so that the teacher needs to get the learner ready to listen for the sound ahead of its production. (7, 20)

Habits of Observation

Prompting learners to pay attention to details of objects is not only a means of increasing the accuracy of a percept, but it is also a means of developing a useful and desirable type of habit. This is the habit of a careful observation of things. After the habit is developed, the learner tends to secure accurate percepts of nearly all objects that come within the range of the senses. Such a person can distinguish, for example, between objects that appear to be alike to less careful observers. The habit also develops a tendency in the learner to initiate and prolong inspection, observation, and study without having to be prompted to do so by the teacher. This, of course, is one of the most desirable outcomes of teaching and training. (1, 6)

Law of Effect

In conditioning, it will be recalled, pleasantness serves to strengthen and unpleasantness to weaken or eliminate connections between particular stimuli and responses. In perceptual learning, both of these factors tend to increase the accuracy of a percept. Experiments have shown, for example, that things which produce pleasantness or unpleasantness are known better than things which do not arouse affective states. Thus, the teacher should make an effort to utilize these factors in the development of percepts. When practicable she may make a definite effort to arouse feelings and emotions in connections with given objects as a means of leaving lasting impressions from them. She should be careful, however, in the use of unpleasantness or annoyance. The reason for this caution is that this factor results in the development of negative responses and attitudes to particular stimuli. Thus, annoyance should not be used as a factor in perceptual learning except when a negative response is desired. The teacher who annoys children by nag-

ging, scolding, or punishing as a means of impressing objects on their minds when they fail to respond correctly to stimuli presented to them runs the risk of building up in them negative attitudes or dislikes for the things she wants them to know. Pleasantness aroused in connection with objects not only results in the development of favorable attitudes, but also in an increase in the strength of the perceptual response. On the whole, perceptual learning occurs most readily and satisfactorily when objects and symbols are made pleasant and attractive to the learner. (7)

PERCEPTUAL LEARNING IN THE SCHOOL SUBJECTS

The acquisition and development of percepts takes place very rapidly in certain of the school subjects. Drawing, nature study, local geography, and reading seem to be the subjects in which perceptual learning is chiefly involved. The first three involve this type of learning in that each concentrates attention on the acquisition of knowledge of concrete things; the last requires a knowledge of symbols. It may be profitable to discuss several of these subjects from the standpoint of perceptual learning.

Drawing

Many students think of drawing as an activity intended to develop motor learning or to discover and develop artistic capacity. To the extent that these are outcomes of drawing, however, they are secondary to the other purposes of the subject. Drawing should be taught mainly to develop: (a) visual perception of particular objects; (b) concepts of classes of objects; (c) proper habits of visual observation; (d) appreciation of such arts as painting, sculpturing, and designing; and (e) a means of communicating ideas of objects to others. (8)

Values of Drawing to Perception

Drawing is peculiarly valuable for the development of accurate percepts, because the act of drawing an object or design carries the learner through the essential steps in the acquisition of a percept. In the first place, the anticipation of representing an object gets the learner in a state of readiness to react to the object in a vigorous manner. In the second place, the activity

forces the individual to attend to the general outline of the object and also to its various details; that is, drawing heightens attention toward a particular object. In the third place, it acquaints the learner with the nature of the object as it is presented visually, and prompts a mental organization of the various details. It is necessary to take the child through these or similar steps, because, as we have seen, he tends to react to things about him in a very superficial manner. If he is prompted to represent things by drawing them, the learner forms the habit of making an active analysis of various objects. Although the perceptions tend to become more analytical as children grow older, drawing tends to hasten the process of analysis. Through it the child not only notices the details but also their relation to each other and to the whole. If he were not required to draw, the child would likely remain ignorant of many things about objects that he needs to know. (8)

Development of Drawing Ability

Drawing is a type of activity that has to be learned, and it is acquired in connection with the development of the ability to perceive. The very young child can make marks on paper, but he cannot draw. His inability to draw is due, first, to his ignorance of the use of lines to represent things, and second, to his ignorance of the form of things that may be represented. The child of twelve months of age will grasp a pencil and make irregular circular marks on the paper, but he does not draw; he merely imitates the gross movements observed in older persons. By the time he is three years old, however, the child can be induced to attend to and to imitate a horizontal or vertical stroke made by another person.

As soon as the child begins to pay attention to visual stimuli, and as soon as he discovers that he can represent what he sees, he can be induced to copy simple designs. At about four years of age the child can copy a horizontal or vertical line, or a cross; at five a triangle; and at seven a diamond. If asked to copy a figure or design that is too intricate for his perceptual ability, he may make the effort, but his product is usually of a very poor quality. A child who is asked to copy a diamond, for example, may produce a circle or a square. The interesting thing about this is the fact that he appears to be satisfied with

his product, and is unaware of its poor quality and lack of resemblance to the model. This fact implies that the ability to perceive has not developed sufficiently for him to analyze the model. This is evident also in the child's efforts to "make" things from memory. He may make a few marks and say, "This is mama"; "This is a house"; "This is a man," but his marks will bear little resemblance to the things he says they represent.

Gradually these imitative drawings are replaced by schematic representations which show the outstanding or marked characteristics of particular classes of objects, but with only enough details for an observer to determine what they represent. By this time the child seems to be able to perceive more than he can represent. Frequently, finding it impossible to achieve a given result by drawing an object as a whole, a child will make the parts first and then try to put them together, producing, indeed, a curious looking drawing. Too, one may try to represent details that he knows exist but which may not belong in his particular drawing. In drawing a man, for example, a child may show both eyes in a profile, or show the legs through the clothing. This type of drawing is usually done by children of seven or eight years of age.

By the time the children reach the age of nine or ten, they become more critical of their drawings and strive for proper arrangement of details, frequently giving much attention to colors, shades, shadows, and even perspective. But if they are not taught drawing, children will likely make little further progress. If taught to achieve desired results, they usually make rapid progress until the age of twelve or thirteen, when those who do not have special capacity usually lose interest in the subject. During this period of improvement the child is usually observant of objects in a critical manner, noticing the details and their arrangements, and striving to reproduce them faithfully. (18)

Drawing and Analysis of Objects

From this description of the development of drawing, it may be seen that perception proceeds, generally, from the whole to the part. The child first reacts to objects in a general and superficial way, but as he grows older he notices the details and their arrangement as they compose a particular object. By con-

fronting the learner with the task of drawing particular objects, one forces him to hasten these processes. In order to draw, one must react now to the object as a whole, now to the parts, now to the whole again—all of which is desirable from the standpoint of developing accurate percepts. (9)

Types of Drawings Useful in Various Subjects

A significant fact regarding the use of drawings as an aid to learning in the various sciences should be pointed out. It is true that simple sketches or diagrams of objects and instruments or apparatus used in sciences are better than detailed drawings for the purpose of fixing in the mind of the pupils the nature of the objects. The effort required to make detailed drawings of such things seems to absorb the energies of the pupils to the extent that their attention is diverted from the objects being studied and is directed to the technique of drawing. Thus, when drawings are used as an aid in learning about complex objects, in particular, it is better to require pupils to make relatively simple sketches or diagrams than to require them to make detailed drawings. The sketches, to be sure, should represent the essential features of the objects as well as the relationships of their various parts. This same rule should govern the teacher in the selection of drawings to represent complex objects or ideas. Diagrammatic drawings and sketches used in this manner are a distinct aid to remembering, to the process of perception, and to learning in general. (11)

Drawing and Appreciation of Art

The value of drawing as a means of developing understanding and appreciation of art is fairly obvious. We may point out, however, that the efforts of the child to represent things call his attention to the numerous devices employed by artists in achieving certain results; and the difficulties, failures, and successes resulting from these efforts are a valuable basis for appreciating the work of others. (9)

Reading

Preparation

The perception of spoken language forms is not the only type of language perception that the child is called upon to acquire.

He must eventually learn to recognize language forms when they are presented to him in print or in writing. This learning is mainly a function of the school, but there are certain stages in learning to read through which the child goes before he starts to school. These stages may be described as (a) imitative, (b) communicative, and (c) word learning, all of which constitute a preparation for formal instruction in reading.

The first stage is illustrated by the child's imitation of the reading posture of older persons. The child picks up a book or newspaper, for example, and holds it before him as he observes others do. He may even perform head movements or other actions which resemble the general movements of others. An examination of his eye movements will reveal that they are not following the lines; and the book or paper may even be upside-down! This type of "reading" is done before the child knows the purpose of printed material.

The second stage is the discovery of the purpose of printed material; that it is a means of communication. In this stage, the child usually makes requests of others to read for him. He not only recognizes that printed material is to communicate language, but that it also tells interesting stories; that there is pleasure and profit to be derived from the printed page. This, of course, is an important stage in his development. It is a basis of motivation in reading.

The third stage is that in which the child learns the particular character of reading; that particular printed words represent spoken words. During this stage he may learn particular words, such as his own name, the names of the members of the family, or various words used in the stories read to him. In learning such words, the child comes to understand something of the nature of actual reading and of the problems that confront him in learning to read. He recognizes, for the first time, perhaps, that printed words represent the spoken words that he uses in communicating with others. Upon reaching this stage, the child is usually old enough to start to school and there to receive formal instruction in reading. (9)

Nature of Mature Reading

The term "reading" has many meanings, but from the psychological standpoint, it is usually regarded as a process of

interpreting combinations of thought units presented to the eye in the form of printed characters, such as letters, words, phrases, sentences, and paragraphs. Any given instance of reading varies in kind, according to the purpose and procedure of the reader. One can scan a book, for example, by getting the thought of successive paragraphs, and by keeping in mind the development of the theme or subject treated. Most reading, however, involves the process of interpreting sentences as thought units. When this type of reading is going on, the reader is scarcely aware of the separate smaller units. His eyes move along the line of print in a series of pauses or fixations, during each of which he perceives or conceives all the portion of the line lying in the field of vision and relates this to what he has already seen and interpreted. The complete process of interpretation consists in getting the meaning of separate phrases and words and of relating these to each other and to the thought content of the whole or larger unit, usually a paragraph. This process involves, therefore, keeping this thought in mind, as it arises, and of anticipating, to some extent, the thoughts that are to arise further on in the material. It can be seen, then, that mature reading is an exceedingly complex process. Since it is, and since it is fundamental in all school work from the primary grades through the university, great care should be taken by the teacher to train the child to read efficiently.

Tasks of the Teacher

The teacher's main task, in training a child to read, is that of presenting reading material to him in such a way that he will develop from the beginning correct habits of reacting to the material. These habits include, among others, the following: (a) the recognition of sentences as units of thought; (b) the anticipation of the sequence of ideas in different types of sentences; (c) the recognition of relatively large units of material, such as phrases, during eye fixations; (d) regular and rhythmical fixations; (e) adopting the speed of reading to the speed of interpretation; and (f) reading with attention and alertness.

The development of such habits, and the avoidance of numerous incorrect habits, depends largely upon the manner in which material is presented to the pupil at the beginning. Much, also,

depends upon the kind of drill and motivation employed and upon the standards of performance upheld.

Beginning Reading

Beginning reading should stress such habits as recognizing sentences as units of thought, phrasing and word recognition, and correct pronunciation, perhaps in the order mentioned. In order to build up these habits, teachers should adopt a suitable procedure.

Teachers, in the past, introduced pupils to reading by having them learn the letters of the alphabet. After much drill in recognizing different letters, the pupils were permitted to learn syllables and words. They were shown, in particular, that words are combinations of letters and sounds, and were taught to recognize them as such. Finally, they were permitted to read simple sentences and stories, with much emphasis upon correct pronunciation, inflection, and expression. This procedure is based on the theory that a complex muscular or mental activity is acquired by a mastery of details first, and a gradual combination of the details into wholes. The theory emphasizes, therefore, the part-to-whole procedure.

In recent years both theory and practice have been modified and essentially reversed. It is now believed, as we have previously suggested, that perception proceeds from the whole-to-the-part and that practice should emphasize this type of learning. Accordingly, the modern reading teacher trains her pupils early in reading in the recognition of short sentences and phrases. An effort is made to emphasize the fact that printed material represents spoken language and that the sentence is the unit of thought in reading as well as in speaking. This is sometimes done by (a) letting the pupil learn a simple story, (b) exhibiting the story on a printed chart or in the textbook, (c) giving drill in recognizing the material cards. Such recognition, of course, depends upon the child's noting only the general contour of the units. Sentences may be recognized as beginning with large letters and ending with a period, and phrases and words may be recognized by means of their length, position in the sentence, height of the letters, etc. Despite such limited cues, the pupil usually learns to recognize a relatively large number of different units before it becomes necessary for him

to learn the letters and their sounds. Letters and syllables are introduced because of the similarities of words, but by the time the child is introduced to these smaller units he has already developed a tendency to react in the proper way to the larger reading units. Without interfering with this tendency, the teacher may now introduce and drill the pupil on pronunciation, inflection, and other sound elements in reading. (17)

Values of This Method

The value of proceeding in this manner is that the child develops proper habits of reading from the beginning. If he is given the letters at the beginning, he develops a tendency to notice each letter in every word as it comes within the range of vision. Also, the correct procedure emphasizes the development of a wide span of perception and the habit of responding quickly to each perceptual unit. It also encourages the child to react to the printed page as a medium of thought or meaning rather than as a mass of words to learn to spell and pronounce. We do not mean to minimize the importance of pronunciation, spelling, inflection, etc., nor the importance of punctuation and diacritical marks, but we are trying to show that the chief emphasis should be placed upon the more fundamental aspects of reading, and that drill on the smaller elements should not supplant the drill for rapid interpretation of the printed page. The latter type of drill, after the first habits have been stressed, will serve to increase the accuracy of the percepts of the larger units. Just as noticing the details of a concrete object increases the speed with which one recognizes it, so will the acquaintance with the details of the printed material increase the speed of recognizing phrases and words. That is, if the fundamental habits of reading are established first, attention to and drill in reacting to syllables and words will not interfere with, but rather will strengthen the total patterns of response.

Introduction of New Words

As the child makes progress in reading, it is necessary to introduce new words from time to time. These should come to the child as a part of his total reading process by being introduced in the context of various stories, and repeated a sufficient number of times for the pupil to learn them thoroughly. Only

a few new words, however, should be introduced in each successive story. Drill on particular words should be used to overcome special difficulties in recognition and meaning, but this type of drill should supplement practice in reading rather than being made a part of it. That is, the child should not react to words singly, except for special purposes, but rather to words in combination, and drill in the latter type of performance should be for the purpose of increasing speed and smoothness. (10)

Reading and Word Recognition

Caution should be made at this point against the parrot-like drill required of pupils by some teachers such as in the use of flash-cards. Experiments have shown that pupils trained with flash-cards recognize words quickly and accurately; but the pupils trained in reading by being given reading exercises excel those trained by flash-card exercises in actual reading. This finding does not mean that flash-cards should not be used in teaching reading, for they develop types of recognition pupils need to make and they appeal to children's interests. It does mean, however, that learning to read involves a reorganization of perceptual elements in which particular words, and even parts of words, must be reacted to in a variety of contexts. It is the practice given the children in reacting to particular words in a large variety of contexts or sentence patterns that develops the ability to read. In other words, reading is one type of process; word recognition is another. The children learn to read by using actual reading material. (10)

Nature Study

Purpose of the Subject

This subject is intended to give children a broader understanding of natural objects and their relationships. Most of the objects dealt with are already known but only in a very superficial manner. The child's percepts are inaccurate and incomplete. He needs, therefore, to acquire additional information and to get acquainted with new phases of his natural environment. The difficulties in bringing objects to the child and in taking the child to the objects often discourages the

proper teaching of elementary science. It is easier to find a greater variety of information about physical and natural surroundings in books than in the environment. Thus, study *about* instead of a study *of* objects is the usual procedure adopted. The truly progressive teacher uses both objects and books, each to supplement and explain the other.

Value of Nature Study

The true value of nature study is that it gives the pupils first-hand familiarity with natural objects and processes. This type of reacting is better than that to materials that have been set down by others, such as that in books. The person who has only a verbal knowledge of any subject or object is likely to make many mistakes which could be avoided by direct experience. The laboratory is a useful source of direct experience, but it is usually insufficient. The pupils should be taken on field trips and excursions and brought into contact with the things discussed. Regardless of the difficulties encountered in giving children first-hand information, the teacher should make every possible effort to see that such information is provided. Laboratory instruction, field trips, exhibitions of collections of objects, and other direct methods of teaching are not intended to make learning more rapid but to make it more certain and permanent. Such activities furnish the sensory data necessary for accurate and complete understanding. They help to keep the learner close to the facts and thereby assist him to avoid the mastery of meaningless verbalizations. (4)

CONCEPTUAL LEARNING

In the next chapter attention will be given to conceptual learning which results in the expansion of percepts into broader understandings, and in the ability to do abstract thinking. The two chapters are so closely related that they should be studied together.

EXERCISES

1. Give the meanings of the following terms: perception, ideation, cognition, interpretation, comprehension, discrimination, and understanding.
2. Describe an example of perceptual learning that is not in the chapter.

3. What is meant by "mental association"? In what ways is there such a process?
4. Give illustrations of perception in infants or very young children.
5. What types of learning appear first in life? Discuss the place of attention and movement in perceptual learning.
6. How does the perception of language develop? Describe the process in detail. To what extent is this development dependent upon maturation?
7. List the elements or impressions involved in perceiving the size of a table.
8. Discuss the significance of G. Stanley Hall's discoveries in regard to the content of children's minds.
9. What are the differences between a percept and a concept?
10. Discuss the statement: "Perception is a gradually developing process."

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CHAPTER XIV

CONCEPTUAL LEARNING

GENERAL CHARACTERISTICS

Definition of Terms

Conceptual learning, as we have seen, is involved in the acquisition of concepts or general and abstract ideas. A *concept* is one's understanding, comprehension, or mental grasp of any idea that stands for, represents, or symbolizes a group of particulars having some definite relation to each other. One's concept of "house," for example, is his understanding of the term as covering or including all kinds, descriptions, and sizes of houses; one's concept of "government" consists of all his ideas about governments of different kinds; one's concept of "ten" is his understanding of the number in a general sense; or one's concept of "verb" is his understanding of a definition of the term. Concepts are usually symbolized in language form by class words, abstract terms, definitions, rules, formulas, hypotheses, laws, principles, and other generalizations. All such formulations are used in everyday speech or in textbooks to cover a group of particulars which bear certain relations to each other.

The term *conception* refers primarily to the formation of a new life; but when it is applied to thinking, it refers to the formation of an idea in the mind. Just as the formation of a new life involves the fusion of a large number of particular characters, so the formation of a concept involves the relating of a number of mental elements. The term implies, therefore, the apprehension of a meaning arising from the observation and consideration of a variety of particular ideas specifically related to each other. (3)

Conceptual Learning Distinguished from Other Types

Perhaps the two types of learning most similar to conceptual learning are perceptual and imaginative learning. In order to avoid any confusion that may result in the student's thinking

because of this similarity, an effort will be made to distinguish the one from the others.

Conceptual and Perceptual Learning

Perception, it will be recalled, involves the recognition or understanding of a particular thing present to the senses. A percept, of course, is the mental product of this process. One has a percept, for example, of a given chair, a certain man, or a particular book, when he recognizes the chair, man, or book now affecting the senses. The chair in which one sits, for instance, may be his "office-desk-chair"; the book on one's desk may be Dewey's "*How We Think.*" Each particular is *perceived.* A *concept* of "chair," or "book," on the other hand, is a very different mental product. The word "chair," when *conceived,* is not *this* chair but *any* or *every* chair; and "book" is not Dewey's "*How We Think*" but any or every book. This type of idea is thus an abstraction that includes all of the particulars within the individual's understanding. Thus, just as perceptual learning is the process of acquiring mental reactions to particular things, conceptual learning is the process of acquiring reactions to symbols which represent a number of things. (3)

Conceptual and Perceptual Learning Contrasted

Since images are mental elements employed in perception, the concept may be contrasted with the mental image. An image, as we have seen, is present in consciousness as something concrete. It has the qualities of concrete things, such as color, form, roughness, etc. A concept, on the other hand, is present in consciousness as a meaning not having definite sensory qualities. Try, for instance, to get a mental image of "pity," "justice," "nevertheless," "whenever," "moreover," "three," or any other abstract idea. When one tries this, he is unlikely to experience any type of percept, except probably a verbal image or the image of some particular object. That is, the stimulus that symbolizes a concept, such as a word, sign, or map, or a particular thing represented in the concept, may be imaged; but the concept itself exists in consciousness only in the form of a meaning.

The distinction being made here does not imply that images are not present in conceptual learning. As a matter of fact,

images play a very important part in conceiving, especially in the formation and enrichment of concepts. Verbal images, in particular, are important, for these are the means by which language forms are usually present in consciousness. Without language there would be few concepts of any value, and without images there would be no language. For when a word or sentence appears in consciousness, it tends to occasion the reinstatement of all of the previous experiences with which it has been associated; and it is these experiences that enable the individual to give meaning to the word or sentence. Nevertheless, since all such experiences cannot appear in consciousness at the same time, there is little conscious content appearing except that which is called meaning. Of course, if the meaning is not immediately apparent, the thinker may make an effort to call up particular images that he can now relate to the symbol, and thus give it a meaning by imaging a particular. (2)

Elements of Conception

The apparent possibility of imageless ideas suggests that concepts depend upon elements other than mere sensory experience. As a matter of fact, the elements that seem to play the chief role in conception appear to be *relations* existing among one's mental experiences. In formulating a definition, for example, one is not interested in sensory data or mental images as such, but in the relations that such particulars may have to each other. His interest, indeed, is in putting together a number of words that will include or symbolize observed relations among a number of particulars. If one defines the term "verb," for instance, he takes into consideration the number of things that different verbs do and attempts to include all of them in his definition. What verbs do, of course, is discovered from a study of a relatively large number of sentences. Similarly, in drawing a conclusion, one summarizes in one statement the facts or data being considered, so that they reveal their essential relationships to each other.

Types of Conceptual Learning

Conceptual learning may be considered as exhibiting three fairly distinct processes: (a) reflective thinking, (b) abstraction,

and (c) generalization. Each of these, together with their products, will be described briefly.

Reflective Thinking

The term "thinking" implies the manipulation of any kind of mental elements in a sequence. The term *reflective thinking* describes the process of adjusting to a particular stimulus or situation by trial-and-error and imitative adjustment. In adjusting to a new situation by trial and error, the learner depends largely upon random trials and chance successes, repeating his efforts to adjust until his mode of action satisfies the requirements of the situation. In order to adjust by imitation, the learner simply copies the performance of another person. In either of these types of adjustment, mental activity is confined almost wholly to sensory data, that is, to the stimulating factors in the trial situation. The learner seems to be little concerned about how he has reacted to similar or different situations in the past. We can say that he responds almost without thinking. In adjusting to a new situation by reflective thinking, on the other hand, the learner is purposively aware of both present and past reactions. When separated into different processes, this type of adjustment seems to involve the following: (a) the learner actively observes and analyzes the new situation in order to determine what mode of response to make; (b) he reflects or thinks back over his past experiences in order to recall responses, facts, or ideas he has employed in reacting to similar situations; (c) he relates the past to the present, selecting those elements that appear to be related to the new situation; (d) he decides what to do, say, or think under the present conditions; and (e) he adjusts in terms of the total process. (6)

Reflective thinking in which sensory qualities, percepts, and images dominate consciousness is called *concrete thinking*. This type is prominent in perception and imagination, in which the individual deals mainly with material things and events. But thinking which involves a succession of symbols of past experiences, and in which meanings rather than specific qualities are actively attended to, is known as *abstract thinking*. When this type of thinking is consciously directed so as to conform to accepted standards of correct thinking, it is usually called *logical thinking*. In this, the learner is concerned mainly with

discovering relations among the various mental elements in order to establish a rule, a law, or a general principle. Logical thinking is the dominant type involved in conceptual learning.

The relations that seem to play the chief role in logical thinking are those previously described as logical relations. These include such factors as similarity, contrast, part-whole, whole-part, cause-and-effect, and number. That is, if the learner is confronted with a new item (object, idea, or principle) whose relations to others previously presented in consciousness are not readily observed, he experiences a kind of "thought crisis" which requires some mode of adjustment. He then casts about, so to speak, to find a "familiar" place in his thinking for the new idea. Such familiarity consists in relating the new to some old experience as a means of giving meaning to it. The meaning, in turn, arises as a result of the relationship or group of relationships observed. That is, the individual thinks, "this is similar to, different from, a part of, the cause of, etc., this I already know"; and the total thought process reveals to him the nature of the thing being observed. (3)

Abstraction

One type of abstraction is the process of acquiring concepts of elements derived from the senses, that is, of sensory or perceptual qualities. In reacting to objects, one becomes aware of their various qualities, such as redness, roughness, coolness, roundness, etc., produced by the stimulation of different receptors. These qualities are experienced in connection with any number of different objects. At first, as noted in the chapter on perceptual learning, they are identified as characteristics or parts of a whole object or event. Gradually, however, they are abstracted from concrete objects with which they have been experienced, and are conceived as things in themselves. One can think of "red," or "round," or "rough," for example, without having to image or think of a particular object. As an independent thought product, a sensory quality becomes a concept or abstract idea. The ability to do this kind of thinking depends upon the existence of language symbols or words which carry or convey the quality apart from direct experience, or even imagery.

A similar but somewhat different type of abstraction is in-

volved in acquiring the meaning of numbers. The child, as we shall observe more closely later, thinks of each number in connection with a particular group of objects, such as fingers and pennies, but as he gains experience, he gradually learns to think of different numbers as independent entities. The expression "five-plus-six," for example, means "eleven" to one who understands numbers, without his having to add five apples and six bananas. The numbers are thus mental elements that have an abstracted meaning, and they can be employed in thinking without being referred to any particular whatsoever. (8)

A still different form of abstraction occurs in the process of *classification*. This process involves the sorting of objects, individuals, qualities, events, ideas, etc., into separate groups. The basis of sorting is a selected distinguishing feature common to the things put into the separate groups. The problem confronting the learner is that of discovering and recognizing the distinguishing feature in each item and of assigning it to the group to which it belongs. As he goes through this process, the learner is forced to deal with individual variations among the different objects, and, as a rule, not one quality alone is observed, but many qualities are distinguished from each other. The total process helps to gain a clearer concept of an entire group of things, and thus the learner is able to think of all the items as one class or group. (18)

Generalization

Another process involved in conceptual learning is known as generalization. This is the process of discovering a general idea from the observation of likenesses common to a number of individual or particular cases. A *general idea*, in turn, is one that covers or symbolizes the entire group of items considered. Most general ideas are expressed in language forms such as definitions, rules, conclusions, laws, principles, formulas, etc. Any such formulation, it may be observed, is an outcome of observation, analysis, comparison, and synthesis of details, cases, or instances that it covers or summarizes.

An illustration will make the foregoing descriptions clearer. A child is told that the area of a rectangle is found by multiplying the length by the width. At first, neither the rule nor the formula has any meaning to the child. Upon being shown a

particular rectangle and its "length" and "width," how to do the calculation, and the area, however, the child begins to understand. If additional examples are presented, and the similarities emphasized, the meaning of the rule and the formula becomes better understood. Now, if the child is encouraged to apply the rule to a number of rectangles of varying dimensions, and taught to verify his calculations, he eventually grasps its meaning and usefulness. That is, he not only grasps the rule and formula but also the fact that it can be used in calculating the area of any rectangle.

The type of learning which this case illustrates is called "generalization" because the learner, from dealing with only a few cases, discovers an idea that covers innumerable particulars. That is, after studying a few examples (objects, facts, cases, etc.) of a common variety, the individual gets an idea that enables him to deal with any specific case. Sometimes, the learner can generalize from a single case, instance, example, etc., but as a rule, he needs to consider several. That is, a generalization is best known when it is developed from a relatively large number of cases. (10)

NATURE AND DEVELOPMENT OF CHILDREN'S CONCEPTS

Basis of Conception

Conceptual learning begins in early childhood and continues, perhaps, as long as the individual is mentally active. Just when particular concepts begin to form is difficult to determine, but it is believed that all concepts begin as hazy ideas and undergo various changes until they become clear understandings. The direction of this development appears to coincide somewhat with the growth of native capacities, for it is practically impossible to teach some things to children until they reach certain stages of maturity. Conceptual development also coincides with the accumulation of sensory experiences, as we shall see later. The relative parts contributed by nature and nurture in the acquisition of concepts have never been accurately determined. What we know is that concepts change with age and also with the learner's background of experiences.

In the discussion that follows, an effort will be made to show how different types of concepts arise and how, apart from the

influence of formal instruction, they undergo various changes with age. Later, attention will be concentrated on the problems confronting the teacher and on the procedures she may follow in assisting children in the acquisition of concepts.

Language Development and Concepts

The foregoing discussion of the nature of the concept should reveal a very close relation between the development of language meanings and concepts. As a matter of fact, language development and concept formation are almost identical processes. This is true because words, expressions, and sentences derive meaning from reactions to objects and events, and because objects and events derive meanings from the language symbols associated with them. Some psychologists maintain that without language symbols there could be no concepts.

Genesis of Concepts

Concepts originate in sensory experiences but appear in recognizable form in particular behavior patterns and in the understanding of language symbols. We know, for instance, that the infant's first mental experiences are sensations, feelings, emotions, and tendencies; and these are the subjective stimuli for reflexes and instincts. These forms of behavior become integrated by conditioning and perceptual learning, so that the child reacts in both positive and negative ways to particular stimuli. Because of such factors as similarity, particular patterns transfer to different stimuli; and complex behavior patterns appear in a variety of situations. While this development is going on, language stimuli are imposed upon the consciousness of the learner. These stimuli function as substitute stimuli for concrete objects and events and serve to call out motor activities. When such substitution takes place, a word, expression, or sentence will serve as a stimulus to arouse practically any mode of behavior. Moreover, the objects and events for which the language stimuli are substituted are known in terms of the language stimuli. The sight of an orange, for instance, tends to call up a variety of mental and motor images, including the words previously experienced in connection with it. These words, in turn, tend to give meaning to the object. If the word "orange," on the other hand, is presented as a stimulus, the

motor and mental experiences previously associated with it tend to occur or to be revived in consciousness as images. The most likely motor response is the pronunciation of the word "orange" together with reaching activities toward the person furnishing the stimulus. When the child acts in this way, we say that he understands the word. When the child is able to react in a social manner to a given object, or when he is able to call the name of an object indicated, we say that he knows what the object is. This type of knowledge we have described as perceptual, and it usually appears at about age three. At this age, at least, the child is able to name such objects as parts of the body, various articles of furniture, and such familiar things as the sun, moon, rain, and snow.

In naming objects and events, the child reveals the first signs of abstraction and generalization. A familiar example is that of the child who calls every male person "daddy." He has discovered, at least, that words stand for certain classes of objects. Proceeding from this, he must discover further that words stand for particular things, for sensory qualities, motor activities, and numerous relationships. While this discovery is going on, of course, the child becomes increasingly familiar with object qualities and relationships—all of which finally result in general understandings. (15)

In order to make clearer the development of concepts, a few illustrations of the ideas of children will be presented.

Early Concepts and Animism

The child's knowledge of an object seems to consist of the language forms associated with it, and his understanding of the language forms arises from the sensory and motor experiences associated with the object. This is seen in the child's efforts to define words that represent particular objects. If asked to point out or to name familiar objects, the child of three succeeds in identifying a relatively large number; but if asked to define a given object not present to the senses, the child reveals marked haziness of thought. A child of three to five years of age usually defines in terms of use. A knife is to cut with, a horse is to ride, a spoon is to eat with, etc. In defining things, the child thus appears to verbalize with a word, phrase, or sentence the actions he would perform toward a given object were it present. That

is, the meanings of things not present exist in the form of language substitutes for actual motor response that the child has made to the objects. What the child does, it seems, is to react to a particular object until his action becomes habitual; and then he is able to use language forms which symbolize his behavior. In other words, what the child says about things symbolizes what he has done to them or how they have affected him.

The facts just suggested are seen in the child's tendency to project his personal experiences upon inanimate objects. Nearly all objects, animate or inanimate, are regarded by the child as possessing life, wants, feelings, purposes, powers, etc., similar to his own. The little girl's doll, for instance, gets hungry, sleepy, naughty, or sick, and walks, cries, eats, etc., like herself. Such ideas are illustrated by many animal stories and in the animated cartoons exhibited at the theaters. The notion that human characteristics belong to inanimate things is known as *animism*, and is characteristic of the thinking of children up to about six years of age. (12, 15)

Artificialism

After the period of animism, children think of objects and their functions as being due to the activities of man. That is, they attribute the existence and activities of objects to the actions of some person or persons. Asked, "What is the sun?" for example, one child replied: "The sun is a big stone which some man made and then made it go up in the sky like a balloon." "A lake," another child replied, "is a hole some man dug and filled with water." This type of thinking has been called *artificialism*. An advanced type of artificialism is observed in attributing the existence and activities of things to God, to Jesus, or to Santa Claus. This type is usually exhibited in children of about six or seven years of age.

Artificialism appears to grow out of the limitations children experience in dealing with objects and out of their observations of the actions of others. The child who breaks his toy finds that daddy or some other person can fix it. Thus things are made and made to work by men. Upon observing the inability of men to deal with some objects, the child attributes them to some other personality, real or mythical, endowed with power.

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This later stage reveals, of course, the influence on children of what they are told about things. The stage of artificialism may last up to eight or nine years of age, and even exist in a limited degree in some adults; but after this age, children who are well taught give more definite explanations of things. The later definitions and explanations of things are due largely to abstraction and generalization of object relationships, which we shall now describe. (12, 15)

Concepts of Relationships

Object Classes and Ideas

Children learn to recognize particular things by synthesis and analysis of details. A step beyond this perceptual type of learning is the acquisition of concepts of different classes of objects and of words which designate the classes. The word "cat," for example, represents to the child at first his own pet and the variety of responses that he has made to it. Later, however, the word designates a large class of similar objects to which the child reacts differently. That is, when the word "cat" is understood to include all of the different cats the learner has reacted to, it has a general as well as a specific meaning. Because of this type of meaning, such words are known as *class ideas.* These ideas appear, it seems, from the observation and synthesis of similarities and differences among objects, and the further observation that a single word can be used to designate all objects of a high degree of similarity. This type of generalization appears at about age eight or nine, when the child begins to observe specific qualities and relationships. At least, a study of children's definitions reveals a tendency to regard words as having a general as well as a specific meaning. (15)

Abstract Ideas

About the age that concepts of the class type begin to appear in the child's thinking, abstract ideas also begin to take form. These ideas are of many varieties, among which the following may be noted: (a) ideas of sensory qualities; (b) ideas of special characteristics; and (c) ideas which have no sensory reference.

The first group of ideas is represented by such words as

"red," "soft," "heavy," etc. These words derive meaning when they are made to refer to sensory qualities. The qualities themselves are perceived at first as details of objects; but after being experienced in connection with a number and variety of different objects, they are abstracted from these objects. When this occurs, each particular quality is known. The word that represents the quality, in turn, becomes associated with the quality as its meaning. Moreover, as the acquaintance with language develops, words can be brought together to form descriptions of classes or particular objects. This type of language development occurs in connection with characteristics of objects and events as well.

The third group of ideas is symbolized by such words as "pity," "justice," "government," and "revenge." These words have no reference to concrete objects, but they refer to situations and events that have to be observed at widely different times and places. Such words seem to become attached to particular instances or examples in which certain characteristics appear and to grow in meaning as instances accumulate. Children's definitions of "government," for example, reveal that they usually identify the term with "police," "court house," "governor," or other tangible things associated with the word. An adequate concept of any such entity requires a large number and variety of associated experiences. Thus, the development of such concepts as these is slow and gradual and is probably never completed. (10)

The basis of abstractions, such as those described above, is the observation of similarities and differences among the characteristics of objects and the substitution of language forms to represent these. As soon as such substitutions take place, the learner becomes increasingly capable of making verbal distinctions between objects and of classifying them correctly. At age seven, for example, the normal child is usually able to state three differences between a stone and an egg; and at age eight, three likenesses of wood and coal. The child is usually fourteen years of age, however, before he can give three differences between a president and a king. These facts indicate that the ability to make distinctions develops with age, and that it is also related to the nature of the characteristics observed. Things that differ in such perceptual qualities as color, size, shape, roughness, hardness, and use, are easiest

to distinguish; those that exhibit highly abstract and artificial differences are more difficult to distinguish from each other. (12, 15)

Whole-Part and Part-Whole Relationships

A concept of the whole-part relationship is the understanding of a complex group of particulars, *one* of which may be characterized or described without reference to the others. The part-whole concept, on the other hand, is the understanding of a particular thing as being or representing some part of an object or class. The whole-part concept is measured by tests which require the individual to respond by naming a part of the whole represented by some stimulus word, or which require the individual to respond by referring to a part when the whole is implied by a question. The part-whole concept is tested by presenting a stimulus word or idea that represents some part of an object or event and requiring the individual to name or imply the whole. Both of these relationships are symbolized in language by any *class term*, and by such words as "all," "some," "part," "only," "one-fourth," etc. The two types of concepts develop at the same time, because familiarity with parts increases the concept of the whole; and familiarity with the whole increases the concept of the parts. In fact, the observation and analysis of any particular thing, which result in the formation of a percept, provide the individual with mental content that enables him to compare and contrast the particular thing in mind with others similar or different. When the comparison is made, abstraction and generalization take place and the concept is in the process of being formed. (12)

The whole-part relationship is better understood by children when the parts stand out with some degree of definiteness than when they are homogeneous. For example, a child of three or four years of age can usually understand the meaning of "some," "part," "the others," of his blocks; but he is unable to understand "some," "others," or "part," of his apple. Such a homogeneous thing as an apple is difficult for the child younger than five or six years of age to conceive as divided. Moreover, children can understand the whole-part and part-whole relations better in concrete than in abstract situations. The ability to conceive a given relationship to any extent, however, depends

upon the individual's background of experience and his degree of general intelligence. (12)

Spatial Relationships

Among the earliest spatial relationships the child learns to conceive are those among objects symbolized by such words as "above," "below," "in front of," "in back of," "beside," and "under." These words are understood in reference to objects present to the senses as early as three or four years of age, but they are not understood in reference to objects not present until much later. At first objects in the perceptual field are located with reference to the self, and later to each other; but spatial relations not in the perceptual field have to be referred to specific distances and directions. In order to conceive these relations, therefore, the child has to become familiar with many symbols, such as "left" and "right," "three inches," "a mile," "north," and the like. Since these symbols are definite in character, their meanings do not appear to the child until he is given specific instructions and practice in using them. Until such training is provided, spatial relations in conceptual form are poorly developed; and even after they are given such training, many persons continue to experience difficulty in grasping these relationships. (12)

Temporal Relationships

Time concepts among young children are less definitely formed than any of those mentioned above. Many tests and experiments indicate that, previous to school experience, any time interval is poorly understood. What ideas children have of time intervals are incident to contiguous events. When children of seven years of age are asked the question, "What time do you have lunch?" for example, they usually give such an answer as, "When daddy comes home from work." Perhaps the reason for the slow development of time concepts is the fact that time intervals cannot be perceived. They have to be experienced in connection with constantly recurring events and associated with an elaborate system of symbols. There is no way of presenting time intervals directly to the senses. In order to appreciate time intervals, the child must become

familiar with the clock and with the days of the week, months of year, etc. (8, 12)

Causal Relationships

Causal relationships are also among the most difficult for children to conceive. Tests have not been devised to show at what ages those concepts arise, but studies reveal something of the nature of the changes. It is believed that they develop through the following stages: (a) things happen because of the child's wants or desires; (b) contiguous events are associated as cause and effect; (c) things happen when some unknown power makes them happen; (d) a true or plausible explanation is given. Asked the question, "Why does it rain?" for example, very young children say, "I want it to rain." Children of seven years of age will usually give some such answer as "clouds," "spring," "weather," or "sun and clouds," illustrating the second stage; or "God," "Jesus," indicating the third stage. The concept of cause in contiguous events may be a logical one, but the events that children relate in these terms often have no such causal relation to each other. The tendency to attribute things to unknown powers is due to previous training and probably to the generalization that the cause of rain lies beyond the range of human effort. The fourth stage suggested appears after much instruction and first-hand experience.

Among causal relationships expressed in our language, a special type is the exception to an implied cause. For instance, the sentence, "Although Italy is as far north as our northern states, it has a much milder climate," implies both a cause and an exception. This relationship has been called the *discordant relationship*. It is usually symbolized by a complex sentence including such a word as "but," "except," "though," "although," "even though," "yet," and "in spite of." Though we use these words in everyday speech in addressing children, not more than 20 to 40 per cent of those of preschool age comprehend the relationship implied. Moreover, in spite of the fact that they hear these words often, very few children employ them in speaking. Thus, it may be inferred that the discordant relationship is poorly conceived. Experimental studies show, however, that the relational words are of

different degrees of difficulty, from the standpoint of both use and comprehension. The order of difficulty is that in which the words are presented above. Studies of the reading of sentences with a conditional clause at the beginning, such as that in the example above, reveal that even fourth and fifth grade children have difficulty with a statement of this kind. They seem to be unable to grasp the relationship implied because of its complexity and abstractness. (12)

Verbal Relationships

By verbal relationships is meant those that exist among ideas expressed in sentences, paragraphs, and other units of thought. A sentence is any combination of words that expresses a complete thought. But the meaning of the words in a sentence depends upon their relation to each other. A particular word may have some meaning when isolated from other words; but when it is used in a sentence, it may derive a particular meaning from the context. Similarly, the meaning of a sentence is derived from the context of other sentences constituting a paragraph. In order to understand language, then, the hearer or reader is expected to relate particular meanings to others in given patterns while the stimuli are impinging upon the receptors. To do this in any efficient way requires years of experience in interpreting and using language.

The development of ability to understand language patterns seems to proceed from the simple to the complex and from the concrete to the abstract. Very young children understand single words before they understand sentences, and they understand short sentences before they understand long ones. Likely the child does not fully understand a series of sentences until he has been in school some years.

Language forms which refer to objects and events to which the child has reacted on various occasions are, of course, the first to be understood, and these are best understood when the objects are personally related to the child. These are such objects as he owns, handles, hears, and sees from time to time. Abstract terms that refer to sensory qualities appear next in order, and then come the terms that symbolize the various relationships described above. As the child gains experience, his understanding of language increases; but great care must

be exercised in supplying language forms to the child so as not to go beyond his range of experience. (5)

Some of the difficulties involved in understanding language are due to the flexibility of patterns and to the use of words which have no concrete reference whatsoever. By flexibility is meant the variety of meanings attached to words. These the child has to discover and learn or else have his attention called to them and have their meanings explained. Words that have no concrete reference whatever are the so-called relational words in our language, such as auxiliaries, conjunctions, and prepositions. The only way their meanings can be indicated is by using them in a variety of contexts and directing the attention of the learner to their functions. This type of teaching is largely a function of the teacher of English.

Development of Number Concepts

The child's concepts of number are relatively late in developing, most children being unable to comprehend number relationships, in particular, until they are trained to deal with them. About all that the preschool child can do with numbers is to recite number names, and many are unable to do this with any degree of accuracy before they start to school. As another example of the manner in which concepts in general arise, we may trace the development of number concepts through succeeding stages.

The first stage in the development of number concepts is that of learning number names in a given sequence. This type of learning is little more than a rote memory process, and is usually stimulated by older members of the family. Parents or others, interested in the child's learning to count, recite number names over and over and urge the child to imitate. This he does with the result that he learns to say the names in the proper sequence up to five or six, within the limits of his auditory memory span.

While this learning is going on, the child is likewise encouraged to apply the number names to various objects arranged in serial order, such as the fingers, and to note that only one number name should be used for each object. At first the child does not comprehend this, for he frequently points to several objects when asked to count, and says one or two number

names, or points at one object and says several number names. Gradually, however, a one-to-one correspondence is observed, so that only one name is used for each object. When the child grasps this one-to-one correspondence, and the fact that the last number name called is not only the name of the last object but also the total of all the objects, he has reached the *counting stage.* He now learns to say in proper sequence the number names he knows and to apply them to different objects, pointing to the objects as he counts. This stage is normally reached at four years of age. At least, the normal child of four years is expected to count four pennies arranged in serial order when told to do so. The directions for this test are, "Count these and tell me how many there are." His compliance with this request indicates that he not only knows how to count but also that he understands the language used to designate counting. More difficult than this formula, however, is the question, "How many pennies are there?" This question is answered correctly by normal children of five, if the number of objects does not exceed four or five.

After having learned to count a small number of objects the child continues to learn number names and to use them with reference to objects not present to the senses. Thus, by the time he is six, the normal child can say the number names up to twenty and can count thirteen pennies arranged in serial order. He can also apply number names to objects of different colors, forms, and shapes. Children of seven years of age count up through the thirties without the use of objects, and children of eight are usually able to count to one hundred. The counting is at all stages most accurate, however, when the objects are in the range of vision, or in the field of perception.

Usually the child has learned to count to a hundred when he starts to school. From this time, he goes through the process of learning to group objects according to number, to combine groups of objects by means of numbers, and eventually to deal with numbers as abstract quantities. The *grouping stage* is reached when the child discovers that he can classify objects in terms of number. That is, the things that he counts do not have to belong to the same class, such as color or form, but they may be any things he may choose to combine. He may count, for example, all the objects on the dressing table, in the

room, or on the wall, and regard all of them as belonging together in terms of number. When he can do this, numbers are no longer regarded as ordinates, as first, second, third, etc., or names of particular objects in a series, but they are regarded as cardinals, or as names representing various groups of objects.

The grouping stage may or may not have been reached by many children when they start to school. The teacher then, should be very careful to examine the pupils' ideas before starting them out with quantities or with figures. That is, many children are urged to learn how to recognize and write numbers and to add, subtract, etc., before they know the meaning of numbers. When numbers are dealt with before they are understood, the learning of arithmetic becomes a memory process which is very difficult to keep going. The teacher should discover the stage of number development of each of her pupils and proceed from this, instead of forcing the child to try to deal with things he does not understand. (8)

PRINCIPLES OF CONCEPTUAL LEARNING

The foregoing discussion of the nature of conceptual learning and its products and of the development of various types of concepts may serve as a background for a consideration of the principles involved in directing this type of learning in children. At any rate, we shall now concentrate attention on various things a teacher should take into account in helping children acquire different concepts.

Importance of the Concept

General Significance

From the previous discussion, it should be apparent that the concept or universal truth is one of the most significant products of learning. It is, indeed, the goal toward which all the different outcomes of the various types of learning should be directed. The products of conditioning, such as conditioned responses and habits, for example, are never ends or goals in themselves; they are rather acquisitions through which the learner is enabled to understand his environment. Likewise, images, percepts, associated ideas, and isolated facts, the products of other types of learning, have value only in so far as they furnish the particular modes of behavior out of which universal

truths are evolved. The solution of a particular problem in arithmetic is of little value unless it contributes to the mastery of some rule or formula by means of which other problems may be solved. All of our acquisitions, of whatever kind, seem to have meaning or value only when they are related to each other in such a way as to contribute to our understanding of ourselves and our environment. General truths or concepts, in brief, constitute the mental equipment with which we are enabled to adjust to our world on a rational basis. (10)

Concepts as Objectives of Teaching

Since the concept is important as a general outcome of teaching, various general truths to be acquired by the pupils should be set up as the specific objectives of each course, unit, or lesson. This, in fact, is the present practice among our most progressive and successful teachers. The modern teacher plans her course of study or units of instruction, first of all, in view of the general objectives or aims of education, such as the seven cardinal principles stated in Chapter XIII. Then she decides upon the generalizations or understandings the pupil should acquire in order to achieve one or more of these objectives. The generalizations are thus the specific goals toward which the study and thinking of the pupils are directed. Finally, the teacher decides upon the types and sources of information which may constitute contributions to these desired goals, and then she directs the pupils in the work and study necessary for the mastery of this information. In this way the teacher is able to insure proper thinking and study on the part of pupils at all times and to avoid much needless waste of time and energy. The pupils may or may not know the general truths which the teacher has in mind for them to acquire, but they are made aware of some specific question or problem in which they are definitely interested, or which can be made to appear worth studying or solving. Eventually, the pupils must be made to know and understand the definite values and significance of their activities. (10)

Methods of Forming Concepts: Induction and Deduction

Meaning and Terms

In approaching the task of assisting pupils in acquiring one or several concepts, the teacher may decide to proceed induc-

tively or deductively. In logical thinking, *induction* is a type of reasoning from a group of particulars to a generalization, and *deduction* is reasoning from a generalization to specific instances. Inductive thinking, moreover, is a process of thinking in which the learner discovers laws, generalizations, and principles, from the observation of individual cases or data. Deductive thinking, on the other hand, is a process of discovering particular facts or data that are instances of a given generalization as a means of developing an understanding of the generalization. (19)

When it is applied to teaching, induction refers to a method of procedure in which the teacher presents a number of particular objects, facts, examples, or ideas for pupils to observe or study; and then proceeds to show the pupils or help them to discover how these are related and how to arrive at a given generalization. That is, the teacher begins with particulars and ends with a generality, or she starts with examples and ends with the statement of a definition or rule. Deductive teaching is somewhat the reverse of this procedure. When teaching deductively, the teacher begins with the statement of a theorem, law, definition, rule, or other generalization; and proceeds to explain, demonstrate, illustrate, give examples of, or prove it, in order to make the pupils aware of its meaning and significance. (10)

Inductive Thinking in Children and Adults

Much of the thinking done by children may be characterized as inductive. This may be seen by recalling the examples of concept formation described above. At first, as we have seen, children react to objects and events as isolated things without regard to relationships or laws. They do this because they are unable to appreciate the relationships that things have to each other. Gradually, however, as experiences multiply and relationships become apparent, objects and events are classified and arranged according to the generalities or laws that are apparent to the learner. The generalizations of the child are rarely correct, however, because they are based on hazy and indefinite data.

The inductive thinking of adults is strikingly similar to that of children in so far as they both arrive at general conclusions through relating particular experiences. All laws, principles,

rules, definitions, or classifications, in fact, are products of inductive thinking. But the conclusions and generalizations of adults are likely to be more accurate than those of children. This is true because adults, as a rule, know more accurately than children the ways in which things are related. Too, adults more than children are likely to recall and relate events of the past to each particular problem or observation that arises.

Nevertheless, the average adult is by no means an accurate thinker. Unless he is trained to observe carefully, and to relate his past experiences to particular problems, the average adult is almost as likely as is the child to jump at conclusions. Many adults, in fact, seem markedly inclined to make bold assertions on the basis of the superficial observations of only a few instances. Such thinking as this is not only inaccurate, but it is absurd; however, it is characteristic of the type of induction that goes on in the thinking of many persons.

The best type of inductive thinking found among adults is that done by the scientist, who has been trained to think in this manner. The true scientist refuses to make dogmatic assertions about anything until he has collected a sufficient amount of relevant data to support his conclusions. Even then, the scientist states his conclusions very cautiously and carefully. Furthermore, in assembling data, the scientist accepts only those which are most accurate and relevant to the problem at hand.

Regardless of how inaccurate induction may be in particular instances, it is the only type of thinking human beings can do by means of which they may establish opinions, beliefs, and certainties. Thus, children should be encouraged and trained to continue to use it. It is indeed the task of the teacher to discover and expose the inaccuracies in the thinking of children and to train them to think as accurately as it is possible for them to think. In order to do this, the teacher should master the art of inductive teaching which we shall now attempt to describe.

Inductive Teaching

Teacher's Plans

In order to proceed inductively with a given course or lesson, the teacher should have rather definite plans in her mind and

preferably on paper. She should work out in advance, in particular: (a) the topics or subjects to be taught; (b) the general and specific aims of each topic; (c) the knowledge she can presuppose in the pupils; (d) the generalizations she wishes the pupils to acquire; (e) the subject matter and illustrative materials she expects to present in class; (f) the most important questions she expects to ask the pupils; (g) the final definitions, rules, or laws she wishes the pupils to know; and (h) a list of directions for pupil activities to be carried out as a means of fixing the generalizations permanently in their minds. If the teacher has such a plan of materials and methods in mind previous to beginning her work, she will save both herself and the pupils considerable time and confusion, and the pupils will come out with clearer understandings.

Additional Comments on Inductive Teaching

A careful study of the preceding plan will reveal a number of additional facts regarding the nature of induction, and also several additional principles that every teacher should remember: (a) As suggested above, the teacher should have very definitely in mind what she is going to do. She should know what generalizations she wants the pupils to acquire, and she should have at hand carefully selected illustrative materials. (b) The generalizations should be within the grasp of the learner, and the illustrations should be of a simple variety. The illustrative materials should illustrate exactly the rule or principle; they should, accordingly, be free of irrelevant details. Complex illustrations which contain irrelevant materials tend to confuse rather than to clarify the understanding of the learner. (c) In inductive teaching, the teacher must have the close attention of the pupils. Their attention must be concentrated on every significant detail in the illustrative materials and on each step in the lesson development. To aid in getting and keeping attention, concrete rather than abstract materials should be used as far as possible, and these should be made very attractive. (d) Pupils should be encouraged to answer each question after studious reflection, and to ask questions about things they do not understand. Incorrect answers should be corrected and the pupils should be shown wherein they are incorrect; however, the teacher must be careful not to give too

much time to the correction of the errors. She should answer questions pertinent to the development of the lesson and ignore those that have no bearing. If the teacher permits the discussion to drift away from the lesson, the pupils forget the main questions and fail to follow the teacher's logic. (e) Because of the strain that inductive teaching places upon attentive processes, each lesson should develop as rapidly as the pupils are capable of thinking. (f) As nearly as possible, everything that is done or said should lead toward the conclusion that the teacher has in mind for the pupils to reach. (g) The pupils, rather than the teacher, should reach the conclusions; but the teacher should assist them in stating the conclusions or facts in clear, concise language. (g) After a conclusion or group of conclusions has been stated, the teacher should give the pupils additional illustrative materials on which to work. These should serve as a means to help pupils remember the principle, law, or definition. After the pupils have worked on the teacher's materials, they should be asked to supply illustrations of their own. This requirement will reveal whether the pupils have generalized their thinking, and it will reveal any weaknesses that may have appeared in their understanding. (10)

Deductive Teaching and Thinking

The Teacher's Problems

In teaching by the deductive method, the teacher starts with a general idea previously worked out by someone else by induction. Her problem is to: (a) present this to the pupils; (b) help them understand it; (c) show them how it applies to particular cases; (d) demonstrate its validity and usefulness; and (e) encourage the pupils to employ it in understanding or dealing with particular cases or problems. In order to accomplish all of this, the teacher is confronted with the additional problems of (a) selecting generalizations the pupils are capable of understanding; (b) presenting these in understandable form; (c) selecting illustrative materials most closely related to the generalizations; (d) preventing the pupils from memorizing the generalizations without understanding them; and (e) giving sufficient practice for the children to generalize their thinking. These problems, of course, are not entirely different from those

involved in inductive teaching. They are, moreover, very real problems in the teaching situations. (10)

Suggestions as to Procedure

The presentation of general statements to children should be as effective as possible. It is good practice to stimulate as many senses as possible, for example, to write a statement on the blackboard and to read it to the class, and also to have the pupils read it. After the generalization has been presented as effectively as possible the teacher should make the pupils realize that their task is to understand it. The teacher should stress here the difference between understanding and memorizing. After pupils have been made aware of their task, the teacher may begin to question them to discover what understandings they already have. As soon as the pupils have been made aware of their need of additional information, the teacher should proceed to explain, illustrate, or demonstrate by reference to particular cases, always being certain that the pupils are following the instruction. When the generalization has been applied to several illustrative cases by the teacher, the pupils should be set to work applying it to similar cases or instances. While they are doing this, the teacher should point out the errors and assist the pupils over the difficult places. After having the pupils make a number of applications under her guidance, the teacher may summarize and list the steps to be taken, and thus show the children the type of thinking they are expected to do. By this time, the pupils should be able to make the applications themselves. If not, the causes of failure should be discovered and the difficulties removed. In order to be certain that the pupils generalize their experiences the teacher should give them a relatively large number of additional exercises to be worked out by themselves. (16)

Type of Thinking Involved in Deduction

It is already apparent that deductive thinking involves the consideration of particular cases in the light of the characteristics of a generalization. This form of thinking may be illustrated by the syllogism; viz., "Verbs are words used in a sentence to express action, being, or state of being." The word "go" in this sentence expresses action. Therefore, "go" is a verb.

Or, "All animals that have four feet are quadrupeds. The horse has four feet. Therefore a horse is a quadruped." The conclusion in a series of propositions of this kind is not a general idea but a specific idea regarding a particular case. Nevertheless, the conclusion cannot be accurately determined until the learner has applied the generalization to a sufficient number of cases to make the meaning of the generalization clear.

The deductive type of thinking occurs in the mastery of many different kinds of textbook material. In botany, for example, the task of the pupil is largely that of learning terms which refer to species and families of plants, and of studying and classifying under these headings the specimens furnished by the teacher or found by the pupil. In general science, the student is given a great many general descriptions, definitions, laws, principles, etc., which he is expected to demonstrate in the laboratory or apply to particulars in other ways. In grammar and mathematics, and even in geography and history, deductive thinking likely plays the major role. (14) The reason for this is the fact that all the sciences consist of generalizations discovered by mature workers in the various fields, and these generalizations are passed on to the novice for his instruction and learning. As a matter of fact, on account of a strong tendency in human beings to generalize their experiences on the basis of a few observed instances and then to employ the general idea as an interpretation of additional instances that arise, it is believed that deduction is the dominant type of thinking found in all mature persons. Only the trained scientist employs pure induction and even his thinking is often controlled by some hypothesis or theory which he is trying to establish as a general truth or explanation. It is quite natural for any thinker to search for generalizations to explain his observations, and in the absence of established truths to set up tentative ones. This, rather than pure induction, is the method of thinking employed by nearly all thinkers, except very young children. Generalization, after all, is an economical method of dealing with a large number of cases. It is easier to use a symbol or a statement to refer to ten or a thousand similar things than it is to refer to each separate thing. We employ all kinds of symbols, such as signs in mathematics or language, to represent a variety of things. Everyone does this except the young child whose

experiences are too limited to result in accurate or convenient generalizations.

Relative Merits of Inductive and Deductive Teaching

Each of these two methods of teaching has its advantages and disadvantages.

Advantages of Induction

Compared with deduction, induction is generally believed to have among others the following advantages: (a) it results, as a rule, in more accurate and clearer understandings; (b) the method provides the better type of training for original and independent thinking; (c) its use encourages a more thought-provoking attitude in pupils; (d) it makes for closer inspection and analysis of the details and relationships upon which a generalization is based; (e) it usually stimulates a greater amount of interest in pupils and thus fosters a greater degree of pupil participation in the class discussions; (f) it tends to cause pupils to form the habit of making inquiries regarding the nature and characteristics of new data; and (g) it stimulates the "research" attitude in pupils in that they are motivated to search for accurate and detailed information. (5)

Disadvantages of Induction

Although it appears to have the advantages just cited, inductive teaching presents certain disadvantages. Some of these are as follows: (a) If used exclusively, inductive teaching is slow and cumbersome; an entire period may be used in reaching a conclusion that the pupils could understand with very little explanation; and it takes considerable time to present a sufficient number of cases or examples to insure generalization. (b) The method, unless it is highly simplified, is often difficult for the pupils to follow, because it requires constant and sustained attention; such attention is difficult for many pupils to give. (c) It requires the pupils to hold in mind a relatively large number of details, which requirement often causes pupils to become lost or confused and thus to fail to have the proper insight or mind set when the conclusion is reached. (d) It forces the teacher to presuppose knowledge which some of the pupils may not have sufficiently well in mind to relate it to the

problem being solved. (e) In order to employ induction the teacher must have a thorough grasp of her subject, and she must understand the nature of the thought process she is trying to induce in her pupils. Many teachers have neither of these types of knowledge. (f) Induction alone rarely ever results in complete generalization. The pupils must be given practice in applying the general ideas they acquire; and the practice, when properly carried out, results in deductive thinking and learning. (5)

Advantages of Deductive Teaching

Deductive teaching has a number of distinct advantages—among them the following may be mentioned: (a) Deductive teaching is a relatively simple procedure, as far as lesson plans are concerned. The teacher does not need to know every detailed step she is going to take. (b) As a rule, more material can be covered because it usually takes less time to present and discuss a general idea than it takes to discuss and analyze a series of ideas, and to draw a conclusion from them. (c) Much of the textbook material the pupils will have to use is written on the basis of deductive instruction. Rules, principles, and generalizations are given the pupils to learn, with illustrative examples of each as a basis for understanding. (d) Many experiences of the race come to us in the condensed form of generalizations. It is much more economical and efficient for the pupils to learn these condensations, together with their uses, than it is for them to undertake to get the experiences for themselves.

Disadvantages of Deductive Teaching

Even though deductive teaching may be seen to have the advantages pointed out above, there are several handicaps possessed by it. Some of these are: (a) It may encourage careless preparation and teaching, and thus lower the teacher's standard of achievement. (b) The teacher may put too much emphasis on "learning the rules," and not enough on their uses. This is very easy to do, since the rules and generalizations are usually emphasized in the make-up of the textbooks. (c) Deductive teaching may encourage too much memorization on the part of the pupils, and may lead them to feel that they have mas-

tered their lessons, when in reality, only a few superficial generalizations have been learned.

It should be pointed out that there is no one best method for any teacher to follow. The nature of the material to be mastered, the age and intelligence of the pupils, their experiential background, the training and experience of the teacher, and other elements too numerous to mention may all enter the total situation into which a teacher's method must fit successfully. Much of the nature of suitable procedure must be decided when the teacher has all or many of these elements where they can be studied and properly evaluated.

Uses of Induction and Deduction

Although a teacher will find it advantageous to plan her work with either the inductive or deductive approach in mind, she should use the method that will best accomplish her aims. In some instances inductive teaching is superior to deductive; in others the reverse is the case. In still other instances, in order to get the best results, the two methods should be combined.

Uses of Induction

Because of the difficulties involved in inductive teaching, the method has not been followed extensively in the past. Recently, however, there is a movement among educators to bring this method into greater use. This movement leads particularly to efforts to introduce and foster the use of the unit plan of teaching in the schools.

The unit plan of teaching, especially in social science, emphasizes the study of topics or problems arising from the pupils' observation and experience rather than from subject matter imposed upon the pupils. The topics or problems are not selected from a pre-established curriculum; they are selected from the pupils' interests and experiences which are brought to light in class discussions. The teacher uses the first few weeks of school to discuss with the pupils the possibilities of work for the semester and gradually induces each class to select some particular topic. The topic may be such a one as "cotton," "milk," "trade," "clothing," or any other thing of general interest. When the topic is selected, it becomes a unit of study upon which the class may work for several weeks or even

months. At first, the teacher discusses the topic and opens up the possibilities of the unit. She proposes tentative outlines to follow and calls attention to many things that might be considered and done during the time devoted to the topic. During the discussions, the pupils are stimulated to raise questions and make inquiries, most of which cannot be answered until additional information is collected. Then the questions and problems raised by both teacher and pupils are carefully formulated and organized as specific objectives in a definite program of work. All of the pupils are then set to work collecting information necessary for the solution of the problem and the attainment of the objectives.

In order to collect the information sought, the class is usually organized into working groups, each of which assumes responsibility for a particular type of information. As far as possible, the members of each group work on the problems in which they are especially interested. The leader selected for each group presides at conferences at which the members discuss their findings and decide what else needs to be done to complete the plans of the unit. At various periods the class as a whole has conferences at which the findings of the various groups are discussed and related to the objectives. The teacher visits with the groups, and with the class, and helps the pupils keep the work progressing. She gives attention, in particular, to the pupils who are having special difficulty and to guiding these in organizing their material. She sees that each group is at work, and that each pupil is a participating member of his group. Though she guides the pupils, the teacher never dominates their thinking. She shifts the responsibility to the pupils, as far as they are capable of assuming it, and assists them only when they are in serious need of help. Her main task is that of suggesting sources of information, and of helping the pupils keep in mind the problems on which they are working. Finally, the teacher helps the pupils organize their findings and reach conclusions which help to clarify the problems on which they have been at work.

This method, it may be seen, stresses the solution of problems rather than the mastery of prearranged subject matter. The pupils in each grade are working on problems in which they are interested, and not on reading, writing, arithmetic, spelling,

geography, history, etc. Material related to all of these subjects may have to be mastered, but not for its own sake nor the future value it may have for the pupils. The pupils learn such material only as they need it to solve the problems on which they are at work. Teachers are usually careful, however, to select projects or topics which will require a knowledge of the fundamental subjects, such as the three R's, and to provide opportunities for drill on the fundamental habits which the mastery of these subjects usually involves. As previously suggested, the unit method appears to be best adapted for use in the social studies, such as history, geography, and civics. It is frequently used, however, in teaching various other types of information.

These comments on the unit plan of teaching are not to be taken to indicate that this is the only way inductive teaching can be used. They should be taken to indicate that the unit plan stresses the inductive more than the deductive approach. As a matter of fact, the inductive approach can be employed in teaching almost any topic children need to know something about, especially if the topic is such that it can be organized about particular problems whose solutions depend upon the mastery of a general principle.

Uses of Deduction

Deductive teaching is usually employed in emphasizing the outcomes of inductive thinking and teaching. When pupils have been led to discover and to understand a general principle, they should be trained to apply it to problems other than the ones used in evolving it. This step involves deductive thinking, and it is an essential step in the permanent mastery of many items of information. The reason it is essential is that a fact or idea acquired at any given time is likely to be forgotten. In order to be remembered so that it can be used when an occasion demands, a general idea must be applied to a large variety of instances and used frequently during the pupils' entire experiences. Like a habit, the general principle must be thoroughly remembered by using it.

When it is used as a definite method of teaching, deduction is generally employed in helping pupils to master information found in textbooks. The teacher usually assigns such materials

to pupils to be read, and then proceeds to teach it to them. This appears to be the most prevalent practice in the public schools. When textbooks are not followed, teachers usually furnish the pupils with an outline of the topics they are expected to study. This method is nearly always deductive in character. The lecture method of presenting materials is usually a deductive approach, although, some teachers build up their main ideas by inductive procedure. It may be seen that deductive teaching is usually the traditional assignment—discussion—testing method of procedure in teaching.

Concept Formation through Reading

The purpose of reading, from the standpoint of conceptual learning, is to master the thoughts set down in writing or print by other persons. Before a reader can do this, however, he must master the mechanics of reading and thus learn how to interpret the printed page.

Development of Reading Ability

The mastery of the reading process itself appears to be a process of development. The stages in the process are somewhat as follows: (a) The child is trained to *perceive* printed sentences, phrases, and words by observing their various characteristics and associating with them spoken words, objects, events, pictures, etc. (b) The reader learns to derive meaning from printed symbols presented in a sequence by observing their relationships to each other and reacting to the combinations as a unit.

Perceptual Reading

The first stage in learning to read has been discussed as perceptual learning in Chapter XIII. This stage consists mainly of training the child to perceive the portion of print that comes within the range of vision as the eyes move along the line of print. The movements of the eyes, it will be recalled, consist of a series of pauses or fixations, during each of which the reader interprets the word or phrase being fixated. The beginner's reaction is usually the pronunciation of the words which the printed symbols represent. This act of pronouncing seems to help the learner interpret the printed symbol. Also, the task

of the learner is to attach meanings directly to the printed symbols so as to avoid the necessity of pronouncing the words or even of thinking of the pronunciation. This type of reaction, moreover, should be quick, accurate, and certain to occur. When the learner develops the ability to react in this way, his eye movements or pauses are usually fairly evenly spaced along the line and of somewhat equal duration.

Conceptual Reading

The second stage in reading consists mainly in associating with each other the meanings that arise during each eye pause so as to produce a continuity of thought in the mind of the reader. By the time the reader reaches this stage, he pays little attention to sentences, words, or letters; his attention is on the total meaning which the printed material is intended to convey. This type of reading is not a process of interpreting visual symbols, as such; it is rather a process of interpreting an entire unit of material, such as a book, a chapter, a topic, a paragraph, or a sentence. That is, the attention of the reader is not directed primarily to sensations, images, and percepts, but to the thought content as a whole—to the theme of the author to which each division of the material contributes and is related.

In order to assist the reader in following the thought content as a whole, the author of the material usually employs such devices as titles, chapter headings, chapter divisions, topic headings, and topic sentences. Under these are the lines of print which symbolize the actual subject matter. If the learner is trained to react to these devices as symbols of the major and minor thoughts, he will find it possible to acquire many of the concepts of the author. That is, by keeping in mind the various ideas represented by such devices, the reader is able to unify his thought process according to the plan and purpose of the author. When the reader does this, his reading is a process of relating, synthesizing, and generalizing—a process of conceptual learning.

The teacher can help the pupil form particular concepts through reading by: (a) calling attention to the title of the units of material and discussing the general meanings; (b) making the reader aware of the topic headings, their meanings, and

their relations to the ideas symbolized by the title; (c) indicating the main thought in each paragraph by pointing out, e.g., the topic sentence; (d) giving practice in doing all this; and (e) by testing the pupil's mastery of the main points and correcting his thinking when it reveals errors.

This type of reading should be emphasized at all grade levels, but particularly from the fourth grade upward. As a rule, pupils in the first four grades are so engrossed with the mastery of the mechanics of reading that they can give only a little attention to the thought content. After the fourth grade the pupil is usually ready to employ reading as a means of acquiring concepts; he is ready, indeed, to study those subjects or work out those problems which involve considerable reading. When used judiciously and carefully, the reading type of mastery is probably the most useful and efficient tool employed in school. Great care must be exercised, however, in preventing pupils from memorizing what they read and from being satisfied with this type of mastery. (5, 10, 16, 19)

EXERCISES

1. Show the differences between perceptual and conceptual learning.
2. Distinguish clearly between perception, conception, abstraction, classification, and generalization.
3. Give five original examples of animism and five of artificialism in the thinking of children.
4. Give original examples of the different types of relationships described in the chapter. Show which of these children would have greatest difficulty in comprehending.
5. Summarize the development of number concepts, showing the different stages.
6. Indicate the basic characteristics of a lesson plan for teaching a specific idea to children by the inductive method, and one for teaching the same idea by the deductive method.
7. Use your lesson plan as a point of reference, and illustrate the advantages of inductive and deductive teaching.
8. What are the advantages and disadvantages of the *unit plan* of teaching?
9. What are the differences between perceptual and conceptual reading?
10. Show how a student should study this present chapter of the text in order to learn its contents most readily.
11. In what school subjects is conceptual learning the dominant process? Illustrate.

12. To what extent should perceptual and conceptual learning occur separately, and to what extent should they assist each other?

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CHAPTER XV

ASSOCIATIVE LEARNING

GENERAL CHARACTERISTICS

Meaning of Associative Learning

Broad Meaning

Associative learning, in a broad sense, may be described as the process of registering and linking together in consciousness two or more mental products (sensations, images, percepts, ideas, concepts, etc.), so that one will serve as a stimulus for the revival of the other or others. In this sense, all ideational learning is associative learning. Perceptual learning, for example, is fundamentally a process of forming connections between sensory experiences; and conceptual learning involves associating events in terms of their mutual relationships. Even sensori- and perceptual-motor learning, which have to do with forming connections between stimuli and motor activities, involve a large amount of association.

Restricted Meaning

But the term associative learning, as it is generally used by psychologists, particularly in the experimental literature, refers to the mastery of materials presented in serial order, such as the following: lists of items, such as objects, numbers, names, states and capitals, vocabularies, and events and dates; of bodies of information, such as prose selections, poems, facts, laws, and principles.

Contrasted with Other Types

The mastering of these types of materials is essentially different from acquiring habits or skills and the meaning of concrete objects and abstract ideas. Whereas, perceptual learning involves acquiring the meaning of a particular object, or conceptual learning the meaning of a law or principle, associative

learning has to do with relating such meanings to each other in a more or less definitely prescribed order or sequence. It might be defined, in fact, as the process of linking items of information together in prescribed sequences so that one will revive another.

The Task of the Learner

The task of the learner, when engaged in this type of learning, is to react to the stimulus items while they are present to the senses, until they become so definitely linked together that one will revive the other in consciousness without the aid of sensory stimulation. In order to learn a poem, for example, the learner has first to receive the sensory impressions. He may not be able to perceive or understand the content accurately, but he has to receive the items of information through some one or more of the various senses, and to register them in consciousness. After the material has been sufficiently registered, and one item associated with another, the learner is able to retain the entire body of material over a period of time, and to revive it in consciousness any time it is needed, unless, of course, he forgets it.

Processes Involved in Associative Learning

Mental Processes

The separate processes involved in associative learning are very similar to those involved in perceptual learning, but there are some differences. These processes are: (a) impression or registration, (b) association, (c) retention, (d) recall, and (e) recognition. *Impression* refers to one's responses to the spoken or printed material and to its registration in consciousness. *Association* describes the process of forming definite connections between the different items being registered and between these and other ideas and facts presented or thought of during a period of learning. *Retention* is the holding or carrying in mind, over a period of time, the impressions and associations made through active study. *Recall* refers to the revival in consciousness, in whole or in part, of the material previously acquired. *Recognition* is the awareness, consciousness, or knowledge that the material being recalled was that previously learned

and not some other experience, fact, or idea that happens to appear at the time recall is attempted. This is another meaning of the term than that of perception as we have previously employed it. Recall and recognition combined are often referred to as *memory*. This may be defined as the process of reviving in consciousness, by means of a present stimulus or by an act of volition, effort, or will, any past impressions, and of being aware that the impressions were made at some definite time or place, or under a particular set of circumstances. Sometimes images and ideas appear in consciousness that we cannot identify, in which case the act of memory would be incomplete. (7)

Physiological Processes

The physiological processes involved in associative learning are likewise very similar to those involved in perceptual learning. Here, however, neural pathways are formed mainly between sensory and association areas of the cortex, rather than mainly between sensory areas. The formation of connections among these sensory and association areas makes it possible for a chain of neural activity initiated by a sensory stimulus, or by a voluntary effort, to continue for an indefinite period of time; until, at least the various items that have been associated are completely reinstated. When this chain of connections is put into operation, the individual is usually conscious of the materials that have been previously associated, particularly when the connections have been well formed. It is possible, moreover, to form connections so well that little conscious effort is required to recall the materials. In this case the connections function more or less automatically. This type of connection is very essential for the most permanent retention.

Aims of Associative Learning

Statement

In directing the learning activities of children in the acquisition of information, the teacher should keep the following aims and problems in mind: (a) to create in the minds of children a desire to acquire new information; (b) to present material in such a way as to make the most vivid and lasting impression; (c) to guide the pupils in forming strong and permanent associa-

tions between the items or ideas composing the information; (d) to utilize those factors that will enable the pupils to retain the information over a long period of time, that is, to prevent forgetting; (e) to insure, as far as possible, satisfactory recall and recognition of the materials at the time they are needed; and (f) to assist the pupils in organizing into useful forms the different types of information.

Requirements for Accomplishing the Aims

Whether the teacher succeeds in accomplishing these aims will depend on her ability to recognize: (a) the nature of specific tasks confronting the learners; (b) the manner in which untrained learners attack their tasks; and (c) how to apply the principles involved in efficient and economical learning.

Suggestions to Be Made

In the paragraphs that follow, an effort will be made to indicate the nature of the pupils' task in this type of learning, the principles of economic learning, and the way in which the principles may be applied in reference to different types of material. Attention will be called, first to the operation of the primary laws of learning and to the principles of teaching suggested by these and by various experimental studies. Later, attention will be given to different methods of learning.

PRINCIPLES BASED ON LAWS OF LEARNING

Readiness

The *law of readiness* operates in associative learning in very much the same way that it operates in perceptual learning. It suggests, at least, the significance of the factors of motivation and mental set.

Motivation

The problem of arousing desires in children to acquire the types of material that involve associative learning depends upon the age of the pupils. Young children, as a rule, like to engage in this type of learning. They particularly like to memorize and recite materials, especially in groups. Perhaps the motive here is to secure the approval of the group; and this

motive can be used by arranging contests to discover who can memorize the quickest and give the best recitation, and by exhibiting records and progress charts. In the case of older children, particularly those of junior high school age, this type of motivation loses its appeal. Children of this age want to know why they have to learn various things. The teacher is then confronted with the task of showing the learner the values of various types of material. This can be done by creating specific problems, the solution of which depends upon a ready recall of the material.

Additional suggestions regarding motivation have been made in previous discussions of the *law of readiness*, where it has been shown that this factor almost invariably increases the speed and accuracy of learning.

Mental Set

AS MENTAL PREPARATION. Mental set may be thought of in connection with associative learning as the *preparation* of the learner's mind for the reception of new information. This preparation consists of prompting him to revive in consciousness images and ideas that may be properly associated with the new material and that will help him interpret it. If the best type of motivation is employed, which is that of creating problems to be solved, the learner may approach the new task with the proper mental set. Otherwise, the teacher should review materials, and gradually work out a specific aim for the immediate task. This type of approach will not only help to insure the proper mental set, but it will help the learner to appreciate the value of the material. Also, the type of mental set aroused will help to control the formation of desirable associations. With a definite aim in mind, and some appreciation of the value of the material, the average child is usually prepared to go forward with the task of learning.

ORGANIZATION AND RELATION OF IDEAS. The most effective types of mental set consist (a) of being aware of the organization of the ideas in the material, and (b) of understanding the relations between these ideas. As a means of arousing the first type, the teacher, in going over an assignment, may show the children how the group of items or the sense material is organized, pointing out the main ideas and the details related to

them. All experiments designed to show the effects of organization on memory indicate that it is a valuable factor. In stressing the logical relations among ideas the teacher gives the learner a mental set that will be of value in training him to think accurately. Too many teachers make assignments merely by telling the pupil what pages to learn for the next recitation, without preparing him in any sense for the task. Much time and effort are saved the pupil when he is made aware of the nature of the materials to be learned.

Intention

Motivation and mental set combined compose what may be called the factor of *intention* in learning. *Intentional learning* is the mastery of a definite body of material for a specific purpose or for permanent retention. It may be contrasted with *incidental learning*, or that which results from casual observation and without definite purpose. One may listen to a speech, read a book, a newspaper, or a poem without having in mind any intention of remembering the content, and still be the recipient of a considerable amount of information. Though valuable in many respects, incidental learning has been found less reliable and less likely to result in permanent retention than has intentional learning. This, at least, is the finding of a number of experimental studies designed to test the products of the two types of learning. Represented in these experiments are many types of material, such as nonsense syllables, numbers, stories, philosophical and descriptive prose selections, material objects, and English and foreign words. In every case, it has been shown that intentional is superior to incidental learning. Both children and adults are more able to recall, recognize, and use materials learned intentionally than materials learned incidentally.

Whether to use incidental or intentional learning in the study of spelling has been the object of much controversy. Some educators believe that children will learn to spell successfully in connection with their reading, as an incidental process. Others contend that much drill and special effort are required to master the correct spelling of each word. The final results of experimental studies designed to test the relative merits of the two types of learning seem clearly to favor the drill method. (10)

It is important in most school work that the teacher urge pupils to study materials with the definite intention of remembering them permanently. Some individuals study specifically for tests and examinations and not for permanent mastery, and as a result, they soon forget what they have learned. It is very desirable to have an intention which sets a goal for learning beyond an immediate need.

Law of Contiguity

In Forming Connections between Ideas

The *law of contiguity* is as follows: "When two or more mental events (sensations, percepts, images, or ideas) occur in consciousness at or near the same time, a connection tends to form between them. If the connection is effected, a subsequent revival of one event, in whole or in part, tends to occasion the total or partial revival of the other or others also." For example, if, for any reason, one recalls an incident that occurred on a fishing trip last week, he tends to revive the whole experience. Or if one happens to think of the first line in a stanza memorized, he tends to recall the entire stanza. This principle, which appears to be verified by everyday experience, has been called the fundamental law of association, because it seems to describe the essential conditions under which association takes place. It implies, at least, that unless mental events occur at or near the same time, functional connections will not form between them.

In Forming Connections between Neurons

Is there anything about mental elements that causes them to be associated in consciousness when they occur contiguously? Apparently there is not, for what appears to be "mental association" is in reality "physical association." What is meant here is that association is due to the contiguous activity of the cortical neurons as described above. That is, unless cortical neurons are aroused and modified at or near the same time, there is no way for them to become connected. The *law of contiguity* is, therefore, perhaps more accurately stated in physiological terms, as follows: "If two or more neurons or neuron groups are aroused at or near the same time, a connection tends

to form between them, so that a subsequent rearousal of one, in whole or in part, tends to occasion the total or partial rearousal of the other or others." Just why contiguous action of neurons in different parts of the cortex tends to result in the formation of synaptic connections between them is not known; but it is reasonably certain that such processes do occur. (4)

In the past, efforts have been made to show that the association of ideas is due to the nature of the ideas, or to some relation between them; but it has never been shown what the relation has to be. The fact is, any two ideas, related or unrelated, can be associated so that one will revive the other, if they can be made to occur contiguously, particularly if they are strengthened by other factors. Thus it appears, as suggested earlier, that the association of mental processes depends largely upon the connection formed between the cortical neurons, and these connections are formed when and if the neurons are contiguously aroused. (14)

Practical Suggestions based on the Law of Contiguity

From the practical standpoint, the *law of contiguity* suggests that, in order to get children to form desirable associations, the teacher must present stimuli that will arouse at or near the same time mental elements which are to be associated. Moreover, since contiguous action of cortical neurons tends to occasion the formation of connections between them, the teacher must be careful not to present stimuli that will arouse ideas that should not be associated. In teaching, it is sometimes as important to prevent children from forming incorrect and undesirable associations as it is to assist them in forming correct and desirable ones. In brief, "the teacher should try to put together what should go together, and to keep apart what should not go together" in the child's mind. (24)

Other Factors Needed

Though the factor of contiguity is essential in the formation of associations, it does not insure that the process will take place in all instances. One may, in fact, experience numerous images or ideas at or near the same time without their being linked together. "Texas" and "Austin," for example, might be thought of at the same time on various occasions without

the two ideas becoming associated. Too, a child may hear the name "Washington," and the date "1732," and yet fail to think of one when the other is suggested to him. Thus, to insure the formation of particular connections, the principle of contiguity needs the influence of additional factors.

Similarity

Meaning and Operation

A group of cortical neurons that has been active at some time in the past tends to be aroused by any stimulus that is similar to the one that originally aroused it. In other words, the stimulus that rearouses a particular neuron or group of neurons does not have to be the original one, nor even another that has been presented contiguously with the original; but it may be still another stimulus that is in some respect similar to the original. These facts constitute the principle of similarity, stated in physiological terms. In terms of mental processes, the law is that "similar images or ideas, though experienced at different times, tend to revive one another in consciousness." The word "cat" for example, may cause one to think of the animal it represents, or it may cause one to think of "spat," "fat," "rat," or any number of things similar to it, either in sound, form, meaning, or emotional appeal. Since there is no known limit to the number of things to which a given stimulus may be similar in some respects, there is no known end to the number of images and ideas that may arise in consciousness when this stimulus acts on the senses. Moreover, as images and ideas arise, they tend to arouse countless others similar to themselves. Thus the operation of the principle of similarity makes it possible for one to think of things that have not been experienced contiguously with the stimulus or idea now present.

It would be incorrect to infer, however, that the factor of similarity is altogether responsible for this possibility; for no one can have an image or idea whose elements have not appeared in consciousness at some time in the past. What appears, then, to be due to the factor of similarity is in reality due to the previous operation of the factor of contiguity. That is to say, the reason one tends to revive ideas that are similar to those

now in consciousness is that the elements of each group of ideas have occurred contiguously in the past. Yet, were it not for the influence of similarity on the activity of the cortical neurons, human beings would be able to think only of those things that are experienced contiguously as complete or whole mental events. With this factor, they possess the ability of recalling parts and bits of previous experiences and of adding them by association to the mental events that are now in progress. This ability, of course, makes for the enrichment and broadening of ideas at any particular moment. (4)

Similarity as a Factor in the Control of Association

Since similar events tend to be revived in consciousness, the problem of controlling the formation of definite associations is very complicated. If a child is being taught to recognize the word "house" and to attach certain ideas to the word, for example, the "ho" part of the word may cause him to think of "horse" or "home" and thus to set up a series of associations quite different from those the teacher wants him to revive.

Although similarity complicates the problem of controlling the associations children form, it is a very useful principle in effecting control. It, at least, suggests the practice of calling the learner's attention to the various ways in which different ideas are *related;* and ideas are related according to the type of similarity that exists between them. Some of the relations that are of special value in controlling associations are *cause-and-effect*, *genus-species*, *general-principle-and-detail*, *whole-and-part*, *part-and-whole*, and *opposites*. By calling attention to such relations, as they may exist in the material presented, teachers will help the pupil to form strong associations of a desirable type. Moreover, the direction of attention to such relations tends to develop desirable habits of thinking in children, for these are the ways in which ideas are said to be "logically related." By pointing out these relations in the material assigned, the teacher not only helps children form strong associations, but she trains them to think logically; and this is perhaps a more desirable outcome of learning than is the mastery of information. In brief, the teacher should know that the child learns to think logically by first learning to appreciate logical relations in material that he is called upon to acquire. She

should also realize that the child should be trained to utilize these relations as aids in the control of impressions and associations.

Limitations of Similarity

Like contiguity, similarity often fails to result in the formation of associations. It is possible, for example, for one to know two persons who look and act very much alike, and yet are never associated in thought. In fact, we have numerous similar experiences that do not become linked in consciousness. In order to be effective in strengthening associations, similarities should be pointed out and emphasized. When this is done, two different ideas or experiences are relatively easy to revive together.

Contiguous Stimulation

Relation to Laws of Contiguity and Similarity

The reader should recognize the laws of *contiguity* and *similarity* as special instances of *contiguous stimulation.* The only distinction to be made between the different laws is that the former is used to refer here to the factors that are responsible for the apparent formation of connections between mental events, which frequently occur apart from contiguous stimulation of external receptors. In our previous discussions, contiguous stimulation has meant the application of two or more stimuli to different sense organs. In the discussion above, contiguity of cerebral processes or mental events, which may occur in the absence of sensory stimulation, has been the background of our thinking. Since associative learning depends upon cortical processes more than upon sensory stimulation, there is need for making a distinction between the two laws.

In other words, there is more to learning than the establishment of functional connections between sensory stimuli and mental or motor events; there is also a central or cerebral process that may function independently of known sensory stimulation. Through the operation of similarity associations may be formed that have no reference to sensory stimulation, except as an original basis. Associative learning is concerned primarily with central processes. (14)

Use of the Senses

This does not mean that the various sense organs are not involved in the mastery of information. They are involved to the extent that they are the avenues through which the learner has to receive the initial impressions. This being the case, we need to indicate some of the facts regarding the functioning of the senses in associative learning.

Variable Forms of Presentation

One of the main problems of interest to teachers is the relative merits of the various senses as avenues of impression. Through which of the major senses, visual, auditory, or kinaesthetic, should the teacher present materials to be learned? Which of these should she induce pupils to employ most when they study? The possibilities in teaching are varied. The teacher, for instance, can present materials so that pupils will employ only the eyes. This can be done by having them read from a book or by exhibiting the items to be learned on cards, charts, or screens; and either of these forms of visual presentation can be made very effective. She can also present materials orally, by reading aloud to the pupils. Too, she can present materials so that pupils will receive kinaesthetic impressions. This can be done by having them read aloud or repeat vocally what they hear, or by having them write what they read or hear.

Which of these procedures is best? The answer to this question depends upon a number of factors, particularly the type of material and the age of the pupil. Very young children learn new words and possibly most listed items best when they hear, because of their greater experience in acquiring information through the ear. Older children who read well appear to memorize better by reading the material. Those who have difficulty with reading tend to learn what they are told better than what they read. This is because the difficulties encountered in reading interfere with the processes involved in learning.

The use of *kinaesthetic impressions* depends upon the type employed and the age of the pupil. In general, kinaesthetic impressions received from reading aloud or from pronouncing items as they are being repeated are helpful for both children and adults. Going over materials in unison, when special atten-

tion is given to the content, often assists impression and retention. Kinaesthetic impressions from writing, such as copying material or taking notes on it, are valuable contributions to learning for pupils and students above the seventh or eighth grades. The use of writing as an aid to learning by children in the lower grades is often a hindrance rather than a help. The reason for this is that children in the lower grades have not mechanized the activities involved in writing sufficiently to free attention for active reactions to the material. It is wise, therefore, not to encourage young children to use writing as an aid to the acquisition of information. An exception may be made to this rule, however, in learning the spelling of words. Here writing should be employed because it is the way that individuals need to use spelling. Writing in this is not employed as an aid but rather as a specific type of habit that should be formed.

Experimental studies related to the use of the senses nearly all show that two or more sense impressions have a greater influence on learning than does a single impression. Nearly any type of material will be learned most effectively, therefore, if all of the senses are used in receiving the impressions. In spelling, for example, the teacher should present the word to the eye and indicate the separate letters; spell the letters aloud; pronounce the word; use it in a sentence; and discuss its meaning. Then she may ask the pupils to copy the word, spell it aloud, and use it in a sentence. (7)

Attention

Functions of Attention

With the proper mental set and apperceptive mass for the reception of material, the learner is prepared to attend and repeat the materials to be acquired. *Attention,* as we have seen, is the process of focalizing consciousness upon a given stimulus for a period of time. In associative learning, the process consists of getting and keeping items in mind long enough to relate them to each other. In effect, the process tends to inhibit other brain processes that may tend to get under way and to emphasize only those involved in reacting to the materials. Since there are various stimuli present to the senses, holding these

in the center of consciousness tends to intensify the total experience. With a strong motive for the sustaining of mental acts, attention may fluctuate from one stimulus or idea to another, until an initial impression is made. During the attentive period the learner likewise has time to contemplate the meaning of the separate items and their relation to each other, and also to revive images of ideas from past experience which may assist him to understand and emphasize the point to be learned.

Importance of Attentive Repetition

The importance of directing attention to the stimulus items and of training learners to sustain a particular process for a sufficient period of time can hardly be overemphasized. The teacher should think of this as a special problem worthy of her constant attention while making assignments. She should be certain that each child is following the suggestions being made; and while directing the learning activities of children, she should be certain that they are attending to the task at hand. Usually, in memorizing different types of material, such as lists of words, multiplication tables, etc., children indulge in a kind of mimic repetition that is worse than useless. That is, they often repeat the materials while their attention is on something else. They may be looking around over the room, for example, while repeating the letters of words in the spelling lesson. In teaching the words in the spelling lesson, the teacher should make the children aware of the waste of time resulting from such repetition and of the value of attentive repetition. By doing this she can soon develop in the pupils the habit of paying close attention to the materials and of repeating them for permanent retention. (12)

Repetition

Relation to Other Factors

Repetition, as has already been suggested, is one of the most essential factors in associative learning. It consists mainly of bringing items to be associated back into attention after they have been superseded by others, and of exercising the connections between them. This process, as we have seen, tends to strengthen the connections and make them permanent. Most

contiguous occurrences, as we have already observed, have to be repeated frequently in order to establish any effective connections between them. Experiments show, at least, that in forming a series of associations, such as those between separate nonsense syllables in a list, or those between the words in a vocabulary, usually the strongest and most permanent connections are those between items repeated the greatest number of times.

Nevertheless, repetition without a motive to learn and without some degree of attention to the material, is rarely effective in learning. One may find the English equivalent of a foreign word a number of times, for instance, and still fail to form a functional connection between the two words. If he looks up the word several times with the intention of remembering the English equivalent, and gives special attention to both words, the repetition becomes effective. The function of repetition, therefore, is to modify neural structures so they will become functionally related. Repetition accompanied by other factors, therefore, is a distinct aid to learning. (4, 12)

Length and Distribution of Practice Periods

Though useful in learning, repetition should be controlled or made to conform to certain general conditions. As a rule, pupils devote certain periods of time to the employment of this principle. How to use the time allotted to study or practice is an important question.

An important discovery made by experimentation regarding the length of study periods is that relatively short periods are more productive than long ones. The best length of study periods in memorizing, for example, appears to be from fifteen to thirty minutes, for meaningful or disconnected material for both children and adults. For mastery of information, such as reading an assignment in history, a slightly longer period is perhaps better, depending on the age of the pupil. If highly motivated to acquire the material, children of the first six grades should not be required to study an assignment longer than thirty minutes at one sitting. High school and college students may, however, profitably spend from forty to sixty minutes continuously on an assignment. At least, the periods being recommended are profitable for the average student. Interest

in the subject, of course, may enable the learner to extend the length of time suggested, for there is little loss due to length of study period when interest is exceedingly great.

If the pupil were not able to learn thoroughly an assignment in the length of time suggested above, it would be necessary to devote additional periods of study to it. He should, in fact, devote as many periods as are required to attain the degree of mastery desired. These periods, moreover, need to be distributed at fairly regular intervals over a relatively long period of time. One period of fifteen minutes a day for four days devoted to memorizing a given poem, for example, is more productive than a sixty minute period of time done at one sitting. As a test of this principle of distributed learning, Ebbinghaus repeated a list of twelve nonsense syllables sixty-eight times. Then he spaced his reading of a similar list in separate periods over three days, testing his learning on the fourth day and found that only thirty-eight repetitions were required to learn it. Thus by a distribution of these study periods, the amount of effort required to learn the given material was approximately half the amount at one sitting. Other investigators have secured similar results for almost every type of material pupils may be called upon to learn.

The reasons why distributed learning is better than continuous or concentrated learning may be stated as follows: Distributed learning (a) helps to reduce the effects of retroactive inhibition; (b) tends to offset the effects of disuse which are greatest immediately after study has ceased; (c) tends to develop greater interest in materials; and (d) will offset the tendency to cram. Some teachers object to the use of distributed learning for the following reasons: (a) it involves some loss of time for the warming-up process that is usually found among children; and (b) because the pupil is frequently unable to cover the assignment in the brief periods that usually accompany distributed learning. The first of these disadvantages can be overcome by the use of strong motives, and by training the children to get under way immediately with their studies. Often the warming-up period is an unnecessary preliminary to active study. The second disadvantage of distributed learning will be overcome by making assignments of the proper length. (7)

The Law of Effect in Associative Learning

Pleasantness and Unpleasantness as Aids to Memory

The *law of effect* operates in associative learning very much as it operates in perceptual learning. That is, both pleasantness and unpleasantness experienced from or in connection with a particular type of material tend to increase the amount learned and retained. For instance, it is easier to remember an exciting event, or an idea that arouses an emotion, than it is to remember a non-exciting event or idea. Experiments have failed to reveal, however, the differences in effect between pleasantness and unpleasantness. Some experiments indicate that pleasantness strengthens associations more than does unpleasantness, but the total results seem to indicate that they have almost equal value. (7)

Uses of Pleasantness and Unpleasantness

The tendency of unpleasantness to strengthen associations is not a helpful factor in associative learning, except in rare instances, however, because unpleasantness tends to develop undesirable attitudes toward the material or subject being studied. It causes, in particular, a dislike for the subject. It is wise in general, therefore, to avoid arousing unpleasant emotional states during learning of this kind.

The teacher may strive to make learning activities pleasant, however, and thus increase their efficiency and develop favorable attitudes. But even here she need go no further than the arousal of relatively strong motives and a high degree of interest. Pupils do not do their best learning when excited, even when the excitement is intensely pleasant; they learn at their best when they are calm and interested in what they are doing. Of course, if a particular connection is very difficult to form, or seems to give unusual trouble, the emotional factor may be employed as an aid. (9)

PRINCIPLES BASED ON THE NATURE OF MATERIALS

The nature of the materials that involve associative learning is such that other factors than those covered by the laws of learning have to be considered in teaching. For this reason, we

shall call attention to various other factors and principles that a teacher should keep in mind.

Meaning

Effect of Meaning on Learning

Ordinary observation reveals that meaningful or connected material, such as prose selections and poems, is easier to learn than is meaningless or disconnected material, such as lists of nonsense syllables or even unrelated words. The difference in difficulty is indicated by the shorter length of time and smaller number of repetitions required to learn and recall a list of English words than is required to learn a list of foreign words or nonsense syllables of similar length. Such a difference is very likely due to the factor of meaning. But it is easier still to learn a poem or a prose selection than it is a list of unrelated words. This is because of the continuity of thought contained in the prose selection or poem which helps to carry the thought processes of the learner forward in terms of meaning. It is his usual method of thinking. In memorizing a list of unrelated or disconnected items, the continuity of thought is broken; each item in the list is a special object of attention, and each association to be formed is a specific task.

Use of Meaning in Teaching

Thus, when materials that the child needs to know can be put into some kind of meaningful context, it is more economical so to present them than it is to present them in lists. Teachers of history often but erroneously have children memorize important events and their dates arranged in the form of a list. The result of such learning is often little more than a waste of time, for the children soon forget both the events and the dates. Materials of this kind should be presented in their proper relations and not extracted as special items. In other words, teachers should make an effort to permit the factor of *meaning* to operate as a means of economizing time and effort. Moreover, teachers should strive to present materials suited to the level of understanding of pupils and to interpret the meaning of that which they do not understand. If the material is beyond the grasp of pupils, they are forced to such extreme efforts as

those involved in the learning of nonsense syllables. The product of such mastery is a mass of verbiage of little significance or value, no matter how glibly the pupils can recite it. By going over the material and explaining its meaning at the time the assignment is made, or at some time before the pupils have spent time studying it, the teacher can save them much time and effort and help to insure a superior type of learning.

Length of Selection

Effect of Long Selections

Another factor that influences learning in a variety of ways is the length of the selection. A selection that is too long has the effect of weakening motives at the outset. Too, an excessively long selection has the effect of increasing the relative amount of time and number of repetitions per syllable or line. Ebbinghaus found, for example, that whereas a list of twelve nonsense syllables required an average of 6.8 seconds per syllable and seventeen readings to learn, a list of thirty-six syllables required an average of 22.0 seconds per syllable and fifty-five readings. Since the long list required more time and reading than the short list, the effort which must be expended on each association is greater. The extra amount of time and effort required to learn the long list seems to be due to the learner's attitude toward the complete task. That is to say, the mastery of a given amount of material is not simply the task of linking together separate items in the list; it is this plus the effort to make each item a part of a coherent whole. Otherwise, the average time and number of readings per syllable would be the same for each list. The learner would have saved much time and effort by breaking the list of thirty-six syllables up into three lists of twelve syllables each. Other investigators have found similar results in the learning of prose and poetry and other meaningful material. (11)

How to Determine Prober Length of Selections

From the practical standpoint, the facts just stated indicate that teachers should be careful not to assign too much material to be studied as a given task. Just how much to assign to a particular group of pupils has never been scientifically deter-

mined because there are so many different factors to consider, such as pupil age and grade, difficulty of material, length of study periods, etc. About the only definite suggestion that can be made here is for the teacher to assign the units of material found in the children's textbooks. Most textbook writers have made considerable study of this problem and have tried to indicate the proper length of lessons for the pupils of each grade.

Primacy and Recency

Meaning and Operation

Two other factors that have been observed to operate in associative learning are *primacy* and *recency*. The *law of primacy* is: "In forming a series of associations, other things being equal, the first ones in the series tend to be stronger than the others." This is illustrated by the fact that one is nearly always able to recall the first item in a list, or the first line in a poem, more quickly and easily than any of the other items or lines. This means that if any part of a selection of material is learned well, it will be the first part. There is a similar tendency regarding the last part of a selection, though it does not seem to be as strong a factor. The tendency to form strong associations at the end of a list is due to the factor of *recency*. Thus, if any parts of a selection are remembered best it will be the first and last parts. The effects of primacy on specific connections are likely due to accompanying effects of motives, intentions, and attention, which tend to weaken as the learning gets under way. The effects of recency are likely due to the freshness of the experience. After a relatively long period of time, at least, recency loses its power to effect recall. (7)

Jost's Law

A special instance of primacy has been called *Jost's Law*, named for its discoverer: "If two or more groups of associations are of like strength, but unlike age, an equal amount of repetition strengthens the older more than the younger." For instance, if two poems are learned at separate times and equally well, and a period of time has elapsed since both were learned, the first can be reinstated more quickly and easily than the second. Or, if one learns the facts in the various chapters of

a book equally well, but at different times, the first chapter will be remembered longer and better than those in the middle or than those at the end of the book. This, it may be seen, is a case of primacy operating in learning which covers a long period of time. (3, 7)

Application of the Laws

The significance of these three principles in teaching may be apparent already. The *law of primacy* suggests that in making an assignment, or in presenting factual materials, the most important thing may be mentioned first; that less emphasis needs to be placed upon first pairs, lines, etc., during repetition for permanent mastery; and that less review will be needed for the first than for the middle and last items in a course. The last suggestion is particularly suggested by *Jost's Law.* Before pressing this principle into active service, however, the teacher should be reasonably sure that the various items of a course of study pursued during a long period of time are learned equally well. The factor of recency suggests the importance of reviewing materials frequently to prevent them from fading from memory entirely.

Retroaction in Learning

Inhibition

One of the reasons the pupil fails to learn all of the items in a series as well as he learns the first and the last is found in the principle of *retroactive inhibition:* "Other things being equal, an association or set of associations just formed tends to weaken associations formed earlier." (7) That is, what a pupil is studying now tends to interfere with what he has just studied. In learning a vocabulary, for example, the studying of each successive pair of words tends to break up the connections between the pairs that have just been studied. In order to overcome the backward effects of serial items, the pupil has to repeat the entire list and give special attention to the relations between the items in each pair, or study a given pair a reasonable length of time and then observe an interval of rest before taking up the study of the next pair.

Effects of Inhibition in Studying Different Types of Material

The principle has much wider application than that just described. It has been observed in laboratory studies, for example, that there is a marked tendency for retroactive effects to appear when the learner takes up the study of a second selection after he has just finished studying a first. If he has just studied a poem, a list of nonsense syllables, a prose selection or a set of pictures, and immediately begins the study of another, similar or dissimilar, the study of the second tends to break up the associations formed in the first. The greatest amount of interference occurs when the second or *interpolated* material is similar to the first, but some interference occurs even when the materials are quite dissimilar. If the learner does several columns of addition immediately after memorizing a list of nonsense syllables, for example, he can recall the list of syllables better than if he has memorized another list. The effects of retroactive action seem to be due to inhibition among the neurons that are activated by the changes from one task to another. It seems that the neurons involved in a given performance continue to be active for a period of time after actual study has ceased; and that the beginning and performance of a second activity during this period of time interferes with these latent processes. (3)

How to Avoid Effects of Retroactive Inhibition

Laboratory studies have shown that an interval of rest observed after studying one thing before taking up another tends to reduce retroactive effects to a very slight amount. A few seconds between the study of a pair of words in a vocabulary and the study of the second pair; fifteen minutes or an hour between the study of Educational Psychology and Psychology; several hours or a day between an intensive review of one subject before a similar review on another subject—any such interval of time serves to increase the amount of material recalled over what it would be if no interval of time were permitted to elapse between study periods. (3)

Reinforcement

While there is a marked tendency for retroactive inhibition to occur, there are instances of learning in which the formation

of a second set of associations strengthens a first set. These are instances in which the second set of materials are closely related to the first, and in which the associations in the first set are strongly formed. If one is learning the causes of the Civil War, for example, the learning of a second cause tends to strengthen the associations made in learning the first. Moreover, if one learns well the first pair of words in a vocabulary, and then studies the second pair, noting a relation between the two pairs, the study of the second pair tends to strengthen the first. If the words of the first of the two pairs are not strongly connected, however, the formation of a connection between those in the second pair tends to weaken the first. This process by which one association or set of associations strengthens another, when the two are formed in immediate succession, is known as retroactive reinforcement. (7)

Significance of Retroaction in Teaching

The significance of these two principles in teaching may be apparent already. They suggest that learning may be facilitated by (a) separating repetition of pairs of items in a series by a short interval of time; (b) providing for an interval of rest between study periods, this interval to vary in length from a few minutes to several hours according to the intensity of study and the length of the first study period; (c) arranging the school program or study schedule so that dissimilar subjects follow each other; (d) making sure, when desirable, that the learner understands one idea before presenting another; and (e) covering up errors in teaching by presenting additional materials before pupils have time to receive lasting impressions of the errors.

Sequence of Associations

Description and Usefulness

By "sequence" is meant the order in which items being learned are associated. A pupil may learn a list of items, syllables, numbers, words, etc., by reading it from top to bottom or bottom to top. He may skip about, reading different parts of a book or a poem, without regard to the arrangement of the topics or ideas. The usual manner of studying, of course, is

from top to bottom and left to right of a page. This is one of the first habits of study that children form, and it is a desirable one in most instances of learning. It is desirable for two reasons: (a) materials to be learned are usually presented in a logical order, or according to some plan of organization; and (b) materials learned in a definite order are easier to recall in that order. Some learners, who have not formed the habit of studying, recalling, and reviewing materials in the order in which they are presented, need to be trained to utilize this factor as an aid.

When to Employ Sequence as an Aid

There are many things assigned to children, however, which should not be learned in a definite sequence; and there are many things that one should learn in a variety of sequences. The learning of lists of spelling words, multiplication combinations, number names, and the like, are instances where sequence should play little part. Children who can repeat the multiplication combinations, for example, are often unable to respond correctly when asked what is 7 x 6, or any other combination, unless they are permitted to start with 7 x 1 and repeat all of the combinations previous to the one needed. Since the tables will be of little value to the child in the solution of problems, there is little need of learning them as such. What the child needs is drill on specific combinations until he knows them readily any time he has need of the knowledge. This is also true of spelling, which should be presented and studied without regard to the placement of the words in the list. (4)

Learning Vocabularies in Sequence

In learning vocabularies, multiplication combinations, and numerous other paired associates, learners often study by associating the items in a left to right sequence only. Then, when asked to recall the left members of a pair by being given the right, the learner experiences considerable difficulty. If the pairs have been learned in a list, the right member tends to revive the next pair instead of the item with which it should be definitely associated. In order to make such associations function as they should, the learner should be given drill and urged to repeat the items in both directions, until either member of a pair serves as a stimulus for the revival of the other.

In arranging materials for children to study, many textbook writers have rightly presented paired associates in both sequences.

General Principle to Follow

Teachers who recognize the "forward drift of consciousness" will suit the factor of sequence to the requirements of the material to be learned. The principle to observe in doing this may be stated as follows: "See that pupils are trained to practice material in the sequence or variety of sequences in which they will need to recall or use it later." (12)

Sequence in History

A question in the study of history has attracted considerable attention among educators. Should history be taught in the order of past to present in narrative form or from present to past in backward form? Since history is logically a narrative of human events, and since a narrative always conforms to the forward tendency of consciousness, the logical method of teaching is from the past to the present. But if this method is followed, care must be taken not to violate another important psychological principle, namely, that events of the remote past are beyond the range of the experiences of young children. When we have historical materials within the grasp of the pupils, the forward sequence or narrative form seems to be easier to follow than the reverse form. Yet, pupils of history should be able to interpret, to some extent, the present in terms of the past. Also, the facts of history should be brought to bear, as far as possible, upon the problems of the present. This can be done as a type of learning additional to that of acquiring the facts of history. It may be seen then, that for learning the facts of history, probably the past to present sequence should be stressed; but for seeing the relations of these facts to present problems, the present to past sequence may be emphasized. The latter emphasis will follow the former, after the facts have been mastered sufficiently well to be recalled and appreciated. In fact, it is impossible to teach the significance of historical facts for present conditions until both types of information have been fairly well mastered. In order to keep within the range of the child's experiences in dealing with historical ma-

terial it will be necessary for him to study recent events. This problem, however, will be discussed later in connection with imaginative learning. (10)

Recall as a Factor in Learning

Effects of Recall

Probably one of the most important of all the factors in learning is recall, or the effort to revive the material in consciousness before it is thoroughly acquired. Experiments designed to test the effects of this factor indicate that it makes for speedy and efficient mastery. Perhaps it is not the actual recall that is effective but the effort to recall; and this seems to arouse the neural processes to more vigorous action than does motive or immediate intention, though these three factors are closely interrelated. Effort to revive the material at frequent intervals has the following results: it (a) enables the learner to discover the weak places or associations in his learning and to give special attention and practice to strengthening them; (b) keeps the subject aware of the amount of progress he is making and thus stimulates increased effort; (c) enables him to discover and correct any errors that may have persisted from wrong first impressions; (d) stresses the principle of learning material in the way it is to be used; (e) holds the learner to a stricter account of himself than does the reading of material; (f) makes for more permanent and accurate retention than does merely reading the material; and (g) increases the amount of attention and repetition and keeps the learner alive and alert to his task. (7)

Recall and Recitation

These results of recall are not to be interpreted to mean that the teacher should devote herself to the recitation method of teaching exclusively. They should be interpreted to mean that the teacher should train the pupils to utilize recall as an aid in their own study. The class period may involve a certain amount of recitation in order to effect the training; but the class period should be devoted to applying the principles discussed above. The pupil should recite to himself, or to another, or other members of the class during his preparation for the

class period. It has been estimated that from one-half to three-fifths of the pupil's study should be devoted to efforts to recall. (7)

METHODS OF LEARNING

In the previous discussion of learning, attention has been given mainly to the factors and principles which the teacher should keep in mind in directing the learner. Attention will now be given to the methods of learning that the teacher should encourage the children to employ. Some of these methods have been tested experimentally and found to economize the time and effort of the learner and to result in efficient recall and recognition. Others have been found less efficient. The methods will be discussed in pairs, and each member of a pair will be criticized and evaluated.

Whole versus Part Method

Description of Methods

Two methods that may be contrasted with each other are the whole and part methods. By whole method is meant the repetition of a selection of material as a unit with attention on the meaning of the content, and upon the place of each item in regard to the others. In learning a poem, for example, the learner reads it through completely, trying to impress the meaning and the individual words upon his mind, so that he can recall the content when he is finished reading. Of course, with one reading he will be unable to recall all of the selection; he may not even be able to recall any of it. So he reads it through again and again until he can repeat the entire selection without looking at the material.

Variations of the Part Method

In learning by the part method, two procedures may be followed: (a) The learner may read only the first line of the first sentence to get the meaning of it and to impress it on his mind. Then, he will read it over and over until he can repeat it without looking at it. After mastering the first line or sentence, he proceeds to the next, and repeats it, in connection with the first, until both can be repeated from memory. This

is known as the *progressive part method.* (b) He may read the second line until he can repeat it by itself, then the third until he can repeat it by itself, the fourth, the fifth, and so on, until he has completed memorizing each line or sentence. Then he goes back over the selection and puts all of the different parts together, so that he can repeat the entire selection. This second procedure is known as the *pure part method.* Since very few learners employ the latter, we shall refer in this discussion only to the former. (16)

Advantages and Disadvantages of Whole and Part Methods

The most practical question regarding the whole and part methods, perhaps, is their relative merits in memorizing different types of material. Which method, for example, should the teacher train pupils to use? Experiments designed to test the efficiency of the two methods have thrown considerable light on this question.

Although the results of the experiments are not all consistently in favor of the whole method, they serve to emphasize certain *advantages* in which it is superior to the part method. These advantages may be summarized as follows: (a) it emphasizes all of the factors of association that have been presented, such as meaning, logical relationships, primacy and recency in correct form, unity of thought, etc.; (b) it makes for more permanent retention and effective recall than does the part method; and (c) it enables the learner to overcome retroactive effects through bringing ideas into proper relation. In other words, the whole method is a type of learning in which the learner puts together materials in the way that he is usually called upon to revive them. The *disadvantages* of the whole method, on the other hand, seem to be as follows: (a) it proves cumbersome and even wasteful in learning material of great length; (b) the middle and more difficult portions of a selection are not learned as well as those at the beginning and end; and (c) it is probably more fatiguing than the part method.

The chief *advantages* of the part method are: (a) it tends to emphasize frequent use of recall as an aid to learning; (b) it enables the learner to check up more frequently on the progress that he is making; and (c) it enables the learner to make more repetitions on difficult parts. It may be apparent that such results are of a nature to attract young children The part

method, however, has many serious ***disadvantages:*** (a) it rarely ever permits the learner to emphasize meaning, unity of thought, etc., except that of each particular part, until he has finished the selection; (b) it tends to increase the number of repetitions and to decrease the amount of attention during repetition; (c) it makes for less permanent retention than does the whole method; and (d) it emphasizes a type of mechanical associations that tend to inhibit effective recall. Such results as these, it may be seen, are for the most part inherent in the method; so that it is practically impossible to remove them. (7)

Modified Whole Method

Efforts to combine the advantages of the whole and part methods so as to eliminate the disadvantages of each have been made, with the result that a modified whole method is now recommended. This method emphasizes a procedure somewhat as follows: (a) select a passage of proper length and difficulty for a particular class; (b) introduce this selection to the pupils as a complete unit emphasizing the factors to which attention must be called; (c) direct the learner to repeat the entire selection while he tries to keep in mind its meaning and the relation of the parts to the whole; (d) after he has repeated it a sufficient number of times to be able to recall any part, direct him to attempt to recall the whole and to prompt himself when he is unable to do so; (e) direct the learner then to observe the parts that he is unable to recall and to go over these until they are better known; and finally, (f) let the learner repeat the entire selection until he is able to recall all of the different items. This procedure, it may be seen, is still the whole method, though it has been somewhat modified. Regardless of the fact that some learners have greater success in using the part method, such a method as the one just outlined proves to be the most economical and the most efficient that the teacher can recommend and train pupils to use. (7)

Rote and Logical Methods of Learning

Description and Uses of Rote Learning

In acquiring much of the information assigned to them, many learners often employ what is known as *rote learning.* This is a mechanical method of learning in which the learner may

repeat the material without giving attention to its meaning. He simply goes over and over it, attempting at intervals to recite it, without noting the relations between the items and without giving attention to the thought content as a whole. During the first few years of school, much of the learning done by children is of this character. Such learning as they do is of habit-forming type, which involves neural connections due to some immediate motive other than mastery of information for future use and need. The motives for such learning are usually social in character, such as the desire to make a display of ability, please the teacher, or to excel the other children. Too often, however, the motive is that of getting out of difficulty, for pupils utilize this method of learning when they fail to grasp the meaning of the material. In other words, children use rote learning because they are incapable of logical learning. This is indicated by the fact that as they grow older children use less and less rote learning. They begin to appreciate the importance of understanding the things they learn and the greater ease of forming associations in terms of meaning. Children need, therefore, to get over the rote learning stage as soon as possible by being trained to learn in terms of meaning, and thus to profit by the factors discussed above. (19)

WHEN TO USE ROTE LEARNING. There are times, however, when rote learning may be employed to advantage, even by adults; for young and old alike find it necessary to learn materials that are not related, and the meanings of which are not important for any particular purpose. Nonsense syllables, numbers, names, letters in spelling, isolated facts, and the like, are perhaps easier to learn by rote than by logical learning.

MNEMONIC DEVICES. In learning materials that are needed at various times, use may be made of *mnemonic devices*. For instance, the number of days in each month may be remembered by "Thirty days has September . . . ," the names of the Great Lakes by "H-O-M-E-S," the colors of the spectrum by "Roy G. Biv," etc. These devices provide such convenient ways of recalling things quickly and accurately that some teachers use them quite frequently; and some memory-training systems are based almost entirely upon them. The practice in teaching should be condemned, except in rare instances; for the reason that the system of mnemonics itself may eventually burden the memory

more than would the materials. Moreover, if such devices are employed, they should be of the learner's own invention, rather than being handed down by the teacher. Memory systems that are based on mnemonics are of questionable value for these same reasons. In brief, instead of depending upon mnemonics, the pupil should be trained to rely upon the factors of learning which have been presented. (7)

Logical Learning

As may be apparent already, logical learning is the method of learning that stresses attention to the meaning, to the logical arrangement of the ideas, and to the relationships between the ideas. All of these things make for both ease and economy in learning, and for the appreciation of the usefulness of the various items of information. The only times, therefore, that logical learning should not be stressed are those in which the materials are beyond the grasp of the learner, at which time rote learning may be employed. It is conceivable that children are profited by learning literary gems, passages of scripture, and the like, without understanding them fully. But in general the teacher should present materials that the learner can understand, and train the learner to master such by logical learning. To this end, the teacher should stress higher motives than those arising from competitive drill, social approval, or the desire for display. The higher motives should include a desire to learn for the sake of using the information acquired in the solution of problems, or for the purpose of understanding better the world about us.

Cramming and Review

Descriptions

Cramming is an effort to acquire a large body of material for the purpose of exact reproduction in a comparatively short time. It is usually employed in hasty preparation for a test or final examination. As such, it should not be confused with a review, which is the process of re-examining materials which have been learned and partially forgotten. Cramming, on the other hand, represents first contact with materials which the learner feels he should know. It is usually a method employed

by the pupil who has neglected his opportunities for study during the period of the course. Cramming may not be confined to a few hours or even a few weeks, but may be spread out over a period of months. The time limit depends in part upon the amount of material that the pupil feels called upon to learn.

Disadvantages of Cramming; Advantages of Review

There are some instances, as in certain types of examinations, in which cramming may be justified; but in general it should be emphatically criticized. Learners should be trained, as we have already seen, to spread their learning over a long period of time, and rarely encouraged in their efforts to acquire a large mass of material in a short period of time. They should be trained, on the other hand, to review frequently what they have already studied; and the teacher should prompt review by emphasizing it in her own presentation. The reason why cramming should be discouraged is that it makes for confusion, haziness of ideas, quickness of forgetting, and inability to use the materials in the solution of the problem. In fact, it seems to violate most of the principles of economical learning. Review, however, results in more permanent mastery, in the proper assimilation of materials, in the enrichment of meaning and of meaningful associations, and in the ability to see materials in the relation to facts that have been acquired since the first contact with the material. For these reasons, teachers should encourage reviews, that is, reviews of each assignment at least once every other day, and an intensive review of all materials that are to be included in a test or a final examination. (19)

FORGETTING

Nature of Forgetting

Nature of Retention

Retention, it will be recalled, implies a state of rest or inactivity during which learned material does not appear in the field of consciousness but which may appear in consciousness when the proper stimulus or situation revives it. The material is retained, not in the form of images and ideas, or symbols of these; but it is retained in the form of connections chiefly among the cortical neurons.

What Forgetting Is; Its Causes

During the time of inactivity or rest, these connections may weaken to such an extent that no stimulus, except the material itself, can be found which will rearouse the neural processes set in operation by the material. When this occurs, the individual is said to have "forgotten." Forgetting, then, is the inability of the individual to revive in consciousness an idea or group of ideas without the aid of the original stimulus. It should be remembered that forgetting is not always due to weak connections. We may be unable to recall an experience at one time but able to recall it vividly at another. In this instance, forgetting is not due to weakened connections but to the dominance in consciousness of ideas and images that are not closely related to those that the individual may wish to revive. Forgetting of this sort is apparently due to inhibitions among certain neurons which may operate freely under favorable conditions. Such inhibitions may appear as a result of a number of counteracting stimuli, such as: (a) emotional disturbances, as intense excitement in the form of joy, worry, anger, or fright; (b) fatigue; (c) drowsiness; (d) physical discomfort, pain, sickness, etc.; (e) vivid ideas not closely related to those that elude efforts at recall, as in retroactive inhibition; and (f) distractions, such as unusual or unexpected sights and sounds. Forgetting of this kind is probably more common than that which results from the weakening of connections which is due merely to the passage of time. (3)

What Happens during Disuse

Just how disuse weakens neural connections is not known. It appears, however, that the plasticity of nerve structure, that enables it to yield to and retain impressions, likewise disposes it to lose the traces or effects of modifications. It seems, then, that if connections are not used during a period of time, they cease to function readily. This weakening of the connections predisposes the individual to forget.

The rapidity with which connections lose their strength seems to depend upon the absence of a number of factors: (a) intensity or vividness of the original stimulus; (b) frequency of repetition or amount of over-learning; (c) strength of motives, vividness

of mental set, etc.; and (d) plasticity. Thus the rate of forgetting depends upon the manner and thoroughness of registration and the quality of the individual's nerve structure.

Good and Poor Memories

A person has a "good" or "poor" memory according to his ability to profit by the principles of learning and according to the quality of the substance composing his nervous system. He may have many "memories," some of which may be much better than others. The dependence of memory upon the quality or nerve structure accounts for the fact that two individuals will forget at different rates, even though the original impressions are conceivably the same in each. To the extent that a person possesses a poor memory because of poor quality of nerve substance, there is little that can be done to prevent ease of forgetting.

Loss of Impressions

Even though disuse tends to weaken neural connections, it seems never to remove or to eradicate them. This is indicated by the fact that one can usually relearn very quickly the things that he once knew but cannot recall. Poems learned in early childhood and believed to be forgotten completely, for instance, may be relearned in a surprisingly short time. Even a list of nonsense syllables that has been learned at some time in the past can be relearned in considerably less time and with fewer repetitions than were required to learn it at first. Thus some trace of each experience remains indelibly registered in the nervous system; so that one never completely forgets anything. (4)

The total effects of disuse, moreover, depend upon the strength of the connections and this depends upon the numerous factors of learning already discussed. By means of a vast amount of exercise, for example, one may overlearn a particular thing to the extent that he will never forget it. Will one ever forget his name, how to count, and the like? If one wants to avoid forgetting, he should practice a thing far beyond the need of immediate recall.

Effects of Other Factors on Recall

One forgets at times, as suggested above, because of the dominance in consciousness of mental events occasioned by

internal or external conditions. Some discussion of these interferences may serve to emphasize their nature and seriousness.

Emotional Disturbances

One of the most disastrous occasions of forgetting in school is that which occurs at the time of critical tests or examinations. This seems often to be due to emotional disturbances. These disturbances may be due, in turn, to any number of conditions. Fear of failing or of not making a good grade, and excitement or worry due to home conditions are perhaps the most common types of emotional disturbances. Many pupils, because of previous conditioning, become so highly "nervous" or excited on tests that they forget almost everything; and they are frequently pupils who do excellent daily work. The best cure for this type of excitement is the frequent use of tests and examinations so that the pupils will become accustomed to them. The teacher should try, moreover, to remove the causes of any other types of worry or excitement in the pupil at times when he is forced to draw on his stock of acquired information. If emotional disturbances are of such character that they cannot be dispelled, the sufferers should be excused from participating in the activities or work requiring recall, until they are in calmer moods. (20)

Fatigue

When inhibitions due to fatigue or other bodily discomforts are quite pronounced, forgetting is likely to occur. The teacher, therefore, should observe her pupils carefully to determine whether there are signs of such conditions among them. She should avoid giving children work that requires considerable recall, for example, immediately after a recreation period; and she should likewise be certain that pupils are not suffering any kind of physical ailment. There is hardly anything that occasions forgetting more than does physical pain or even mild discomfort. (20)

Persistent Ideas

Inhibition, due to persistent ideas that seem to refuse to leave consciousness but prevent other ideas from arising, can be overcome to some extent by trying to observe a period of

rest during which no effort is made to think. That is, make an effort to forget everything, including the task at hand, and let the mind wander or indulge in an unrelated fancy, for example, until the thought processes can be focalized upon the task of recalling the desired information. In taking quizzes or examinations, it is frequently helpful to relax a minute or two after answering one question before taking up another. Whatever type of inactivity one may resort to, it often prevents him from forgetting what he knows. (23)

Rate of Forgetting

Variations According to Time Intervals

One of the most important practical questions regarding forgetting is the rate at which it takes place, or its amount at different intervals of time after initial impression. This question is important because its answer indicates the intervals at which materials should be reviewed or repeated for permanent mastery. The data exhibited below, showing the percentage of nonsense syllables and poetry forgotten during certain intervals of time, give a fairly clear idea of what to expect.

Interval of Time between Learning and Testing	Percentage of Nonsense Material Forgotten	Percentage of Poetry Forgotten
5 minutes	2	0
20 minutes	11	4
1 hour	29	22
8 hours	30	25
24 hours	32	30
2 days	39	33
6 days	51	58
14 days	59	70
30 days	80	76
120 days	97	92

Variations According to Type of Material

Two general facts are revealed by the data above: (a) nonsense (meaningless) material is lost from memory much faster than is poetry (meaningful) material, especially during the first twenty-four hours; and (b) forgetting takes place most rapidly the first two days after learning and proceeds more and more slowly up to fourteen days. At the expiration of one hundred

and twenty days, there is still a small amount of retention. A curve of these data, constructed by laying off the intervals of time on the base line and the percentage forgotten on the vertical line, will reveal, therefore, the following characteristics: (a) a rapid initial drop, indicating rapid forgetting immediately after study; (b) a gradual decline, indicating little or no forgetting. Though all forgetting does not proceed exactly in

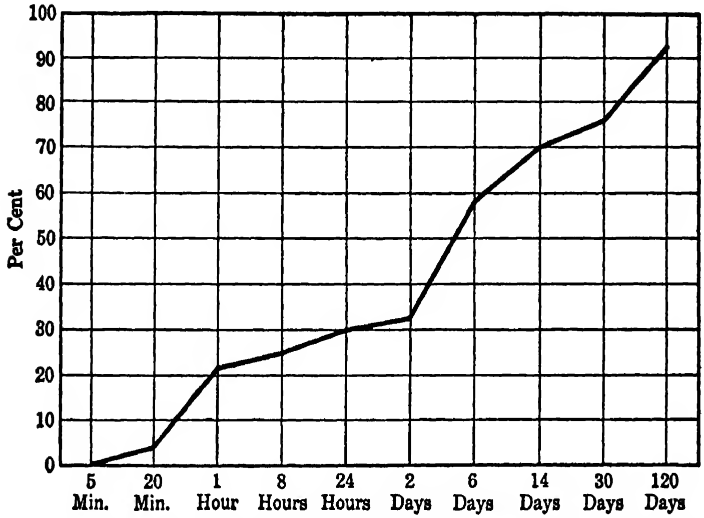

FIG. 33. Showing percentage of poetry forgotten during different time intervals.

the manner revealed by the data, any one case of forgetting appears to exhibit these main characteristics. (11)

How to Avoid Forgetting

It is apparent, therefore, that the teacher may partially prevent her pupils from forgetting by (a) making material meaningful to them, and by (b) having them review what they have studied at least one day after study and at less frequent intervals thereafter. One of the most practical devices for stimulating reviews is a short objective test over the previous lesson and longer tests at intervals of two or three weeks. A final examination is needed at the end of a course as a means of stimulating an intensive review and synthesis of a large body of material.

Variation According to Individuals

There is a popular notion that persons who learn quickly also forget quickly. This notion, however, has not been fully verified by experimental studies. The facts of the matter seem to be that pupils who learn meaningless or disconnected materials quickly tend to forget it faster than those who learn by the whole method and who make use of logical associations. Those who forget quickly, on the other hand, usually employ the part method and learn by rote. Thus the speed of forgetting is closely related to the method of learning employed. In learning meaningful material, it appears that slow learners forget faster and in a greater amount than do fast learners. It is likely that the rate of forgetting here is related to the degree of understanding of the material, those who understand being able to learn quicker and easier than those who fail to understand. There is some evidence to the effect that most rote learning results in quicker mastery than does logical learning, but materials acquired by rote are more quickly forgotten than those acquired by the logical method. This is perhaps the basis for the popular notion indicated above. Nevertheless, it is not the speed of learning that determines the rate of forgetting; it is rather the method and the amount of understanding present in the process.

EXERCISES

1. Compare the neural and mental processes involved in associative learning with those involved in perceptual learning. What are the main differences between the two types of learning?
2. State five laws of learning, and for each law formulate five rules for the teacher to follow.
3. Can there be association without contiguity of the elements associated? Explain.
4. What functions does similarity appear to perform in learning?
5. State the advantages and disadvantages of distributed practice.
6. Write a paper on the uses and values of the Law of Effect.
7. Discuss the effect of the length of selection on the rate of learning.
8. Point out the practical principles suggested by the laws of *primacy* and *recency*.
9. Summarize the practical principles suggested by the effects of retroaction.
10. Criticize the following statement: "The teacher should always present materials in a definite sequence."

11. Indicate the occasions on which the whole and part methods of memorizing should be employed.
12. Contrast *rote* and *logical* learning. What are the advantages and disadvantages of each?
13. Distinguish between *cramming* and *review*, and point out the advantages and disadvantages of each.
14. List the factors that contribute to forgetting.
15. Why does forgetting go on most rapidly immediately after study has ceased?

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CHAPTER XVI

IMAGINATIVE LEARNING

INTRODUCTION

Meaning of Imaginative Learning

The term "imaginative learning" is used to describe the process of acquiring knowledge, information, or understanding of objects, persons, and events not present to the senses. The stimuli for such a process may be present to the senses in the form of concrete objects or language, but these are only symbols by which the things learned are induced to appear and take definite form in consciousness. The things themselves are in the nature of objects and events of the past, present, or future, and usually at a distance from the learner. For instance, one may study the life, character, and conduct of George Washington, and come to know the man and appreciate his character and his deeds; yet, the learner can never react to Washington or his acts as immediate stimuli. The things being studied are absent from the senses in both time and space. Also, one may learn about the customs and modes of living of the people of Greenland. These are present realities, but they are far beyond the range of the senses in space. Furthermore, one can imagine persons and events that may probably play a part in his experience tomorrow, though none of the things he imagines may ever happen. Or, he may imagine the outcome of an experiment that he is performing and rejoice to see it concluded as he imagined. Thus this type of learning involves images and ideas of the future. (4)

The process by which things of the past, present, and future take definite form in consciousness is known as *imagination,* and the process by which such things become known and understood in definite ways is called *imaginative learning.* This type of learning, it may be seen, is primarily involved in the acquisition of history, geography, and other similar subjects, which deal with objects and events beyond the range of the sensory and perceptual experiences. (9)

Elements of Imaginative Learning

Much the Same as Those of Other Types

At this point the student should reread the discussion of sensations and images in the chapter on perceptual learning. There it was pointed out that all mental content originates as sensations; that after sensing their qualities one can revive them as images; and that having sensed and imaged an object in a variety of situations and through a number of different senses, one is able to perceive or recognize it as a definite thing in terms of the stock of images one has accumulated. After this development, known as perceptual learning, one is able to proceed a step further and revive images of percepts and deal with them and ideas about them without the aid of sensory stimuli. When he does this, he can arrive at many facts or items of knowledge that relate to things he does not and cannot know directly. When he takes this step, the individual is engaged in imaginative learning. This process is made possible, of course, by the operation of the various principles of learning already discussed. These principles have described in a general way how mental events become linked together. (9)

Summary

The elements of imaginative learning are: (a) original sensory data, or sensations; (b) images or revivals of sensory qualities; (c) percepts, knowledge of various objects and events from direct contact; and (d) numerous groups of associated images, ideas, and concepts resulting from everyday experience and from careful study under the direction of educators. In other words, imaginative learning is made possible by the accumulation of experiences through other types of learning. (14)

CHARACTERISTICS OF IMAGINATION

Differences between Memory and Imagination

In Recognition

Since imagination is the essential process involved in imaginative learning, the student should understand its nature and characteristics. The process was described above as the means

by which things of the past, present, and future take definite form in consciousness. It is thus very similar to memory, except that it is not limited to the past and present and does not involve definite recognition of the origin of the experience. Whereas, in memory one recalls a definite past experience and recognizes what he recalls as an item of his experience, in imagining he recalls images or complex groups of images which he may or may not be able to recognize as having been experienced, especially in the form in which they are present. His mental content, in fact, may consist of fanciful or strange mental pictures that seem to be in a measure unreal, or they may present themselves as real images of a definite experience. In other words, products of the imagination may conform with fact or reality, or they may consist of combinations of entirely unrelated experiences which for one reason or another appear in consciousness together. (4)

In the Nature of Things Recalled

Another distinction between the products of memory and imagination is that the latter are "flavored" with definite qualities. That is, they appear to have some definite color, form, taste, smell, sound, touch, feeling, and the like, as if they were the results of sensory stimulation. The products of memory, in so far as they are unaccompanied by images, do not appear to have these qualities. Memory products usually appear in consciousness in the form of language symbols or ideas that have been associated with, and which now symbolize, the actual experience. For example, one may remember his mother, her name, and various facts about her, without reviving images of her. If one stops to give place in consciousness for imaginary processes, however, he can see her standing before him, hear her speak, feel her hand touch his, and experience the feelings of joy which he actually knew in her presence. Again the child can recall and recite from memory any number of facts about George Washington from a story he has heard, but he cannot see and hear George Washington as a living human being. In this manner, imaginary processes deal with definite or concrete mental events that are accompanied by particular qualitative experiences, while memory deals more with ideas and the general features of things recalled. Moreover, memories are con-

nected only with experiences of the past, while images may be of the past, present, or future. (5)

Phases of Imaginative Learning

The complete process of imagination exhibits various phases or aspects, according to the nature and complexity of the mental activity being described. These phases may be designated by the following terms: (a) imaging, (b) imagery, and (c) various types of imagination described in the next paragraphs.

Imaging

The term *imaging* refers to the relatively simple process of reviewing in consciousness the mental copies of elementary qualities derived from the senses. These fall into various classes, according to the different types of sensations, such as visual qualities of color and form; sound, tastes, and odors; tactual, kinaesthetic, and organic qualities; and numerous affective qualities. Such qualities may be experienced without reference to any particular stimulus, but they are in effect mental copies of sensations. (4)

Imagery

This is the revival in consciousness of images of particular objects, persons, events, and words suggested by definite stimuli. For example, the sight of a white house may call up the image of a brown house; the sight or image of a canoe may revive the image of a ship; the word "horse" may revive an image of Black Beauty; or the word "man" may revive an image of savage warriors or of Mr. Smith. Moreover, any one object or word stimulus may revive several images and set in motion a mental activity involving various images. When words act as stimuli, the images may not be mental copies of definite objects but of some sensory quality of the word itself. Hearing the word "philosophy," for instance, may revive a visual image of it as it appears in print, or a kinaesthetic image as if it is pronounced or written, or a visual sensation or image of the word may revive an auditory or kinaesthetic image of it. The revival of images of definite objects, it will be recalled, is known as *concrete imagery*, while the revival of visual, auditory, or kinaesthetic images of *words* is known as *verbal* imagery.

Both types of imagery, it may be seen, include mental copies of percepts. *Concrete imagery* may be of any sensory variety, such as visual, auditory, tactual, kinaesthetic, etc., while verbal imagery may be visual, auditory, and kinaesthetic. Verbal imagery is limited to these three types because it is only through the three types of receptors implied that language symbols can be experienced, except in the case of blind persons who now use tactual receptors. (7)

Reproductive Imagery

A third process that involves the revival of images is known as *reproductive imagery*. This process is a definite effort to revive the different images involved in a particular experience. If one tries he can revive the breakfast experience he had this morning, experiencing now the various qualities of the actual experience. That is, he can now experience to some degree the sights, sounds, tastes, smells, movements, and feelings that he experienced while he was eating breakfast. Here the process is one of reviving an actual experience in the manner in which it occurred; the individual "reproduces" the experience. This process is called by some authors *reproductive imagination*. There is no such thing as "reproducing" an experience, of course, for images are invariably less vivid and distinct, less clear in outline, more fleeting and changeable, and more difficult to maintain or hold in attention than are actual experiences.

The closest approach to reproductive imagery or imagination is *eidetic imagery*. This is a process by which the individual appears actually to see the object that he has observed. After observing a picture, for instance, a subject seems to continue to see it after it is removed. In such a case, the image appears to stand out with a great degree of clearness and definiteness. In experimental studies of eidetic imagery subjects are usually asked to look intently at a picture for ten to thirty seconds. At the expiration of this time, the subject is asked to look at a gray cardboard screen, and to report whether he can continue to see the picture. If he reports that he can, he is asked to name and describe the objects in the image. In experimental studies conducted in this manner, many children and a few adults have been found who are capable of eidetic imagery. Even though the pictures are often very complicated, many

subjects reproduce them in great detail. In some instances, subjects name and describe every object in a complicated picture as accurately as if the picture were present. Some subjects will reply to a question about a picture, using an ordinary memory image; then they may project their eidetic images on the screen and get information from it which enables them to correct their first replies.

Eidetic imagery appears to be always of the visual type, and to be found more prevalent in children than in adults. However, there are possibly other types, such as auditory, illustrated by the action of a person who can reproduce a tone vocally after hearing it. Moreover, there may be more adults who are capable of eidetic imagery than are generally known. Nevertheless, the functions seem to appear early in life, and gradually to grow weaker with age. (3)

TYPES OF IMAGINATION

Following are the terms used to designate the different types of imagination: (a) reverie, (b) personifying, (c) constructive, (d) productive, and (e) creative. The classification is based mainly on the relative complexity of the thought processes involved.

Reverie

An act of imagination that is controlled or directed only by the idle wishes or fancies of the individual is known as *reverie*. In this state, the individual allows his mental processes to weave any kind of thought pattern that may appear. The only control that he exercises, as far as he is aware, is that which is in terms of idle wishes or fancies. At least, this seems to be the chief characteristic of the daydream type of reverie or of actual dreams. When daydreaming or dreaming, the individual appears not to have any goal in mind, but such processes seem to conform to some extent to his desires and inclinations, and particularly to his feelings and emotions.

Personifying Imagination

Perhaps one of the most primitive and elementary types of imagination has been called *personifying imagination*. This is exhibited in little children when they attribute to inanimate objects the personal traits they find in themselves. The little girl thinks of her doll as experiencing pain, as being bad, or as

eating and sleeping, just as she does. Savages or very ignorant people are known to think of disturbances in the elements, such as thunder and storm as being the voices of huge human beings. This type of thinking is doubtless responsible for the myths of ancient peoples and for many of the superstitions of ignorant and even some sophisticated moderns. Personifying imagination is an easy mode of thinking by which to explain the mysterious or unknown without seeking the facts in the case. Little children engage in this type of thinking until they discover the inadequacy of it, and then it is usually abandoned for more productive types of thought. (13)

Constructive Imagination

One of the most serviceable types of imagination is known as *constructive imagination.* This is the process of supplying images from one's own experience to construct the word pictures described by another person. For example, when one reads the first stanza in Gray's *Elegy Written in a Country Churchyard,* which begins with, "The curfew tolls the knell of parting day," he tends to image each object, sound, feeling, etc., suggested by the words and the total thought content. The word "curfew," for example, may call up an image of a bell in a church steeple; the word "tolls" may start the image bell to ringing; and the expression "parting day" may arouse a feeling of quiet loneliness accompanied by images of fading colors that accompany a sunset. None of the actual scenes suggested by the poem is known to the reader, but the words and thoughts which are conveyed serve as stimuli for the arousal of various images of things he has experienced. By combining these with the thought content of the poem, the individual is able to construct a mental picture that strengthens his present understanding and appreciation of the poem. The process of constructive imagination, of course, is controlled by the language stimuli that the individual receives and by his own efforts to make his imagery content conform to that in the mind of a writer or speaker.

Productive Imagination

Still another type is known as *productive* or *creative imagination.* This is similar to constructive imagination in that it in-

volves a combination of old elements of experience in new or novel ways to produce a given result. In this the mental processes go beyond observed events and enable the individual to predict or anticipate the outcome of a given combination of images. Thus it may be seen that productive imagination is the type which deals with future events.

Creative Imagination

This is the function of consciousness which underlies the ability to make preparations for an undertaking, such as a visit, a long trip, a scientific expedition, an experiment, or a celebration. Though employed by everyone to some extent in the everyday affairs of life, creative imagination is at its best when employed by a person well trained in a given field, such as an artist who produces original works, a scientist who discovers new laws and principles, or an inventor who designs a new instrument.

NEURAL BASIS OF IMAGINATION

Nerve Connections

The neural processes involved in imagination, as far as they are known, are similar to, if not identical with, those involved in associative learning. Images, as has been indicated, conform to the laws and principles of association in the same manner as do ideas. That is, the contiguous arousal of different groups of cortical neurons tends to occasion the arousal of other groups. For example, if an auditory stimulus is presented at the same time with a visual stimulus, and the combined stimulation is repeated a sufficient number of times, a connection is formed between the neurons of the temporal and occipital lobes. Consequently, when the auditory stimulus is subsequently presented alone, it will arouse an image of the visual stimulus, and probably also a group of images resulting from other pre-established connections. This principle, together with the principle of similarity, thus appears to account for the possibility of successive images, and for the combinations of images suggested above. (4)

Receptor Processes

Some psychologists believe, however, that images probably occur as a result of processes going on in the receptors. For

instance, the image of the color red is not due to the arousal of cortical neurons previously aroused by the color, but to some indirect stimulus affecting the retina. Similarly, the verbal-kinaesthetic images experienced in connection with thinking about words, such as those in incipient speech, are not due to cortical activity alone, but more to processes going on in and among the receptors and reactors. Thinking, from this standpoint, is described as sub-vocal speaking or incipient speech. There is some introspective evidence to support this view in that each word or thought seems to occasion a movement of the tongue and other vocal organs; but so far these processes have not been demonstrated. The most widely accepted view regarding images is that they are centrally aroused, being the results of cortical activity. The fact that individuals are aware of images as coming from the various senses is due to previous presentation to the senses of the object imaged.

PHYSIOLOGICAL EFFECTS OF IMAGINATION

Although imaginary events depend upon cortical activity, there is evidence, of an anecdotal type, that indicates the prevalence of various physiological activities going on while the cortical activity is in progress. In an hypnotic state, for instance, a patient made to believe that he is being burned, is alleged to feel the pain as if it were real. Too, anyone may be made to experience fatigue by imagining that he is exerting himself, as if running, lifting, or resisting. This is especially true in the case of dreams, from which a person may awaken feeling completely exhausted. In activities of this kind, however, it is possible that cortical energy is being discharged into the organs affected through the sympathetic ganglia. The impulses involved find outlets to the tissues just as they do in emotional disturbances. As a matter of fact, a vivid imaginary experience is not unlike an actual one, except that it is aroused by internal rather than external stimuli. In other words, images are not the effects of physiological processes going on outside of the brain, but the physiological processes are the effects of the imaginary events. The connections for nerve discharges between the cortical areas and the visceral and somatic organs have been established during waking life by means of condition-

ing. Now that a central process is initiated by a symbolic stimulus, such as a word or suggestion, the impulses have effects similar to those they have during waking life. It is nothing wonderful, therefore, that we use incipient speech when we read or think or that we experience fatigue when we imagine ourselves running. The cerebral cortex is a great storehouse of potential energy, and this energy can be released by numerous stimuli other than actual objects or events present to the senses. This energy can also be transmitted from the cortex to the visceral and somatic reactors any time it is aroused in an amount sufficient to use the lines of discharge prepared by previous conditioning. (11)

IMAGINATIVE LEARNING IN CHILDREN

Beginnings of Imagination

Organization of Sensory Experience

Sensations and percepts, which form the basis of imagery and imagination, are acquired from the moment of birth throughout life. Upon coming into the world, as has been pointed out elsewhere in this text, the infant is assailed by innumerable stimuli, which not only arouse every possible variety of sensation but also the various instinctive acts. The result of the stimulation is at first the mental "blooming, buzzing, confusion" and the random aimless movements characteristic of infancy. Later, however, and gradually, the sensory and motor elements are organized into definite patterns of thought and action. Beginning with sensations arising from chance stimulation, and with grasping, squeezing, pushing, pulling, holding, and dropping of objects, the young child is eventually conditioned to respond to each stimulus in certain and various ways. This comes about as the child becomes increasingly aware of the sensory qualities of the stimuli to which he is conditioned. These sensory elements become connected first with the motor activities and finally with the kinaesthetic sensations occasioned by the movements. With these sensory qualities, the child gradually combines those occasioned by language stimuli, and eventually acquires the ability to perceive or know

particular things. (Review this process in the chapters on perceptual and conceptual learning.)

Imagination and Language

After the sensory impressions are finally registered in the cortical tissues and functionally connected with each other and with motor activities and language stimuli, the individual is able to revive images of any previous experience and to think or act in terms of these in the absence of sensory stimuli. This ability, of course, is basic to voluntary or purposive behavior; for the mental content may direct motor activity independently of external stimuli. Ample evidence of this type of development is exhibited in the child's responses to language stimuli. For example, one may ask a small child, "Where is Kitty?". Immediately the child begins to look about, or actually to run about in search of the missing pet. Here, in addition to his perception of the question, the child employs various images. These may include an image of the kitty, images of the objects about him behind which the kitty may be found, and probably various kinaesthetic images which he utilizes in directing the various movements. In brief, after the child has acquired a variety of sensory and perceptual experiences by responding to things present to the senses, he can revive these in consciousness in ways that enable him to deal with the things when they are absent. He may not utilize all of his past experiences in any given pattern of behavior, but he utilizes those that the mental situation or problem requires.

Differences between Children and Adults

The foregoing description of the beginnings of imagination in children indicates that even very young children are capable of employing elementary forms of all the different types of imagery and imagination described above. The difference between children and adults in respect to imagination, therefore, is not found in the types they each employ but in the amount or degree to which they can use each type in completeness of their respective imagery. In the paragraphs below, an effort will be made to describe some of these differences and to show why they appear. The object of this discussion is to suggest the types of training needed to improve upon the imagination of children. (13)

Use of Concrete and Verbal Imagery

One of the main differences between children and adults is in the amount of use made of concrete and verbal imagery. Children, it is believed, use a great amount of concrete and comparatively little verbal imagery; adults employ much verbal and little concrete imagery. Experiments indicate, at least, that children tend to think in terms of objects and concrete situations, and that adults tend to think in terms of words. This difference is due to the lack of language experience in children. When they think of an object, its image and the images of related objects, rather than words and ideas associated with the object, appear in consciousness. As a rule, children have only a few language ideas associated with it which may appear in consciousness as images. Moreover, children learn about objects best through the various senses and not through the use of words which describe them. Adults, on the other hand, think of objects, not in terms of the qualities that they are capable of arousing when present to the senses, but in terms of the words they are capable of arousing. In other words, because of the various values of language in thinking and expressing thought, adults substitute language symbols for concrete objects in most of their thinking; and this substitution has a tendency to cause verbal rather than concrete images to appear more frequently. Besides, the adult acquires more of his information about objects through reading than does the child; so that the adult has this as an additional source of verbal imagery.

Use of Imagery in Abstract Thinking

The reason that adults substitute verbal for concrete imagery is that such images make for economy in abstract thinking or in dealing with abstract subjects. A word or other symbol, as we shall emphasize later, gains meaning and significance by being associated with a large number of concrete objects and situations; and as a result, it increases its range of suggestion as a symbol. Therefore, instead of trying to revive each or all of these concrete images, the adult needs only to image the word or symbol that stands for them. This type of imagery is thus easier and more economical, once language or other symbols have become substitutes for various objects and events.

A few people have special ways of imaging abstract things which interfere with their speed of thinking. Any number, for example, may be imaged by reviving in consciousness a group of objects which it represents. The number "five," for instance, may appear as a group of dots ::·, or as a series of marks /////, or it may stand for a group of five persons. More interesting still, a few people have formed the habit of thinking of numbers, ranging from 1 to 100, as being arranged in a circle, a square, or a triangle, or even an irregular figure or a cube or pyramid with bends or corners at the tens or twelves. Some persons *see* units of time, such as a day, week, or year, in some novel form, such as a circle or chain. Such "number forms," as they have been called, seem to appear in early childhood, before the abstract meaning of number develops, as a concrete means of remembering the series of names employed in counting. They are, in effect, a kind of mnemonic device for counting. Later, however, when numbers have to be dealt with as abstract elements and used as units of thought in calculations and solving problems, these forms seem to hinder the individual, blocking his progress and interfering with his speed. (4)

Images and Reality

A third difference between children and adults is the manner in which they each regard their images from the point of view of fact or reality. Children find it difficult at times to distinguish between their reproductive and productive images. That is, they are not always certain whether their images are a product of actual experience or a product of imagination. Thus, it is not uncommon for a child to report seriously as a fact some unusual or remarkable experience that he has only imagined. This type of confusion is often due to erroneous interpretation of sensory stimuli which have set off the imagination. For example, the young boy sees a dog and perceives it as a lion; a cat and interprets it as a tiger; a man and thinks he is a bandit; and he may proceed to relate a tale of horror or adventure in which the monster he creates plays a role, and in which he pictures himself as a brilliant hero. Such a product of imagination as this is more than misinterpretation, however; it is a mixture of this and productive imagery, and of a desire to secure the approval, approbation, or sympathy of his hearers.

The misinterpretations are the results of superficial attention and observation and probably of limited associations with the sensory elements. The productive imagination suggested is the effect of a mental set occasioned by the desire for social approval, or of some other tendency, and probably of the lack of criteria by which to judge the difference between actual experiences and the products of imagination. Small children, in other words, do not know enough of the world about them to appreciate actual conditions. To them the world is full of mysteries with which their unreasonable imagery is in full accord. Thus, having to live in a world of fancy, the small child naturally turns his fancies in the direction of satisfying his various tendencies. However, when children are made to see the preposterous elements in their stories, they are ready to retract. (7)

Credulity

The inability of children to distinguish between products of actual experience and imagery is responsible for their characteristic credulity, or readiness to believe anything they are told. This makes them accept uncritically the fairy story and myth or other fanciful creations. When, through experience they begin to find various kinds of sensory elements present in their percepts, however, they begin to doubt the truthfulness of the most glaring inconsistencies. While emerging from this period, they begin to inquire of persons who tell stories, "Is it true?" "Did that really happen?". And they pour out a deluge of questions about every unusual event that occurs. They seem to feel very keenly their need of facts and principles that will help them to understand their world. (13)

Vividness of Images

The differences in the vividness of images of children and adults very probably has been overestimated. It has been asserted by many that children have more vivid imagery than do adults. There is no way to test the validity of the assertion, of course, but there is every reason to believe that adults have more vivid imagery than do children. The vividness of an image must depend upon the intensity and clearness of the percept that it represents. If this is true, children must have

comparatively weak images, for, as we have seen, their individual percepts are hazy and indefinite and their stock of percepts is exceedingly limited.

The vividness of imagery varies with individuals and with age but apparently not in the inverse order. That is, some children have more vivid images than other children; and some adults have more vivid images than other adults; but adults, in general, have more vivid images than children.

Variation in Vividness of Imagery among Individuals

The relative vividness of different types of images likewise varies with individuals and to some extent with age. In general, it has been shown that visual imagery is more common and more vivid than any other type, except in the case of congenitally blind persons, of course, who have no visual images. This vividness of visual imagery is probably due to a number of reasons: (a) the eye, being the most sensitive sense organ, gives the most vivid sensations; (b) the eye is capable of being moved about, and of receiving impressions of objects and events at a distance from the individual; it is used more than any other sense organ in reacting to a greater number of things; (c) most of the things children are trained to perceive are presented through this sense. Nevertheless, there are numerous persons who use the ear or the kinaesthetic and tactual senses more than they use the eye, and these persons seem to have clearer and more vivid images through one or the other of these senses than through the eye. Because of their differences, some persons are classified as visuals, some as audiles, some as tactuals, etc., according to the use made of the various sense organs in securing impressions, and according to the clearness or vividness of the various types of images they have. Most persons, however, seem to be capable of imaging almost as clearly through one sense as another. This mixed-imagery type is probably desirable, and thus may be seen the need of presenting objects and other items of information through each of the various senses. Differences between children and adults in the relative vividness of different types of images, seem to be of no great importance. As children grow older, of course, they become increasingly capable of using the different types of imagery. (4)

Use of Constructive Imagination

There is a decided difference in the ability of children and adults to make use of constructive imagination. As they read, the mental processes of children are so completely absorbed with perceptual processes that they are not able to construct the pictures described in printed form, even when they are familiar with the things described. They seem to read at times not only without getting the meaning but also without seeing the picture. Reading of this type involves little more than elementary forms of verbal imagery, such as that involved in pronouncing words seen in print. Adults, on the other hand, may read a selection of descriptive prose and construct the picture so completely as they read that they can make a drawing of it or describe it in their own words. Even when children are able to use verbal or constructive imagery, the separate images arise so slowly that the reading process is greatly inhibited. That is, the tendency to revive verbal images in reading often leads to the complete pronunciation of the words, and this process is slower than the process of recognition. Likewise, the effort to revive concrete images necessary for the construction of the picture, tends to slow down the reading. Thus, children need to be trained to read rapidly as one process, and to employ constructive imagery as another. Even the reading of adults is slowed down when their attention is concentrated on the elements of the picture being described. As a rule, however, drill in rapid reading with some amount of attention to images, tends to hasten the imagery processes as well as the reading process.

Use and Understanding of Symbols

The most significant of all the differences between children and adults, perhaps is found in their respective capacities to appreciate, understand, and use *symbols*. By *symbol* is meant any word, expression, object, drawing, or other character that is used to represent a complex object, process, action, or idea. All language, of course, is symbolic in that it represents particular experiences, and we have already observed how difficult it is for the child to use language in its correct form. There are other forms of symbolism that the child is called upon to ac-

quire, however, which ordinarily receive less attention than language, and which it may be profitable to discuss here.

The young child exhibits a tendency to employ symbols early in life. In piling up blocks during play, for example, he may notice a resemblance of his product to a house, an archway, a fence, or other familiar object. The arrangement of blocks is then identified with the object and improved upon with the idea of completing the creation. But very young children are satisfied with very meager resemblances of their symbols to the things symbolized; so that anything can be transformed into the furnishings of an enchanted palace, and his work or play into actions suited to the imaginary world. For the time being, the child is living in another world which he may be loath to leave for a time. As the child grows older, the symbols he employs must bear a closer resemblance to the things they represent. In imitative play, the playhouse furnishings must bear a striking likeness to the things imagined. The development here closely parallels the development in drawing previously described, in that the symbols become more and more similar to the things they are made to represent. Gradually, playthings must be real things, in most instances, and as a consequence, the wholesale use of symbols is abandoned. Nevertheless, much symbolism remains and will continue to occupy a large and significant place in the thinking of every individual. What would history and geography be without pictures, charts, diagrams, maps, and globes; mathematics and science without tables, graphs, and signs; music without scales, notes, measure bars, and prolongs; literature without fables, parables, metaphors, and similes; or the daily newspapers and magazines without comic pictures and cartoons? The thinking of the adult would be ponderous, indeed, if he were not trained to appreciate, understand, and use the symbols accepted as standard ways of communicating ideas. (13)

The chief point to be emphasized here is that the crude symbols employed by young children not only give way to the symbols of close resemblance used in later childhood and early adolescence, but these later have to be abandoned for highly specialized symbols used in mature thought, and these often have little or no resemblance to the things symbolized. When the child of twelve to fourteen comes to deal with many of the

symbols that adults can easily interpret, such as a complex picture, a fable, or a parable, he often misses the point completely. Though educated adults find these the most convenient mode of thinking and conveying ideas to others, the young child tries to give them a literal meaning, and the adolescent goes away bewildered and confused. In order to understand symbols, every child must be made acquainted with the ways in which they represent the facts, ideas, or principles that he is being taught before they have any meaning or significance to him. (7)

IMPROVEMENT OF IMAGINATIVE LEARNING

Training Imagination

Old and New View

The popular view of imagination is that it is a mental faculty or power that can be trained by giving the individual a series of special exercises, just as a muscle is trained by exercising it. The view of imagination being presented here is that it is a kind of a mental process that is involved in one way or another in almost everything a person does. There are some types of mental activity, however, in which imagination is the dominant process, just as there are other types of activity in which muscular activity is dominant. In general, therefore, improving or training the imagination as a special power or faculty is out of the question. What the teacher can do is to present the child with various situations which will call out types of reactions in which imaginary processes are chiefly involved. This type of training is calculated to give the learner an opportunity to employ a particular type of mental process.

Importance of Imagination

In Recall and Anticipation

Imagination is sometimes thought of as involving thinking about the unreal and fanciful, such as that used in the creation of fairy stories and myths or the exaggerated stories of children. The view presented above is that imagination is involved to some extent in almost every act of behavior whether motor or mental. According to this conception of the term, it may

characterize all recall and recognition, and especially the anticipation of specific actions. In its most dominant forms, however, imagination is important in (a) reviving actual scenes of one's past experience; (b) constructing the word pictures one hears or sees in print; (c) creating any new thing; (d) anticipating any coming event or set of circumstances; and (e) in planning any particular course of action. The poet or story writer, the business man, the scientist, the artist, or any other person of creative ability, exercises imagination not only as much but also more than the child who imagines a strange or startling adventure. The poet and the story writer must be able to produce in mind what they put on paper; the business man must plan his business quarters and anticipate the demand for his products; the scientist must conceive molecules, atoms, gravitation, and plan and execute his experiments; and the artist must first imagine his final product before he puts it on canvas or in stone. (4)

In School Work

Imagination is important in school work for the reason that the child is being trained to do the things that persons of the type described above are able to do. At every turn, the pupil is called upon either to recall an experience he has had in the past in the form of reproductive imagery or to construct a mental picture of some scene described by a speaker or writer. He may even be called upon to exercise the productive or creative type of thinking in making some definite plans for the future. In history, geography, science, and even in mathematics, the child is called upon to imagine.

It would be unnecessary, therefore, for the teacher to go outside of school activities and subjects for ways to improve imaginative processes. What she needs to do is to study each task assigned the child in order to discover what type of learning is dominant in the mastery of it, and then proceed with a method that will call that type of learning into action.

What Improvement of Imagination Involves

Summary of Processes

The previous discussion of differences between the imaginative processes of children and adults should suggest the main

problems confronting the teacher. From this discussion, it is clear, at least, that children need to be: (a) trained to perceive clearly, accurately, and quickly; (b) given practice in reviving and using images of past experiences; (c) guided in forming definite associations between their images and language forms: (d) taught and trained to make their imaginary processes conform with and to realities; (e) helped to overcome their slavish credulity of unreliable informers; (f) guided in their efforts to construct accurately the pictures described by speakers and writers or suggested by symbols employed in different subjects; and (g) given opportunities to plan, organize, and invent.

All of these needs may be supplied by teachers in helping children adjust to the varying situations of everyday life in school or out, and by stimulating imaginary processes in the mastery of the various school subjects.

Perception and Imagination

Perceptual Training Basic

As suggested above, imaginary processes depend upon perceptual experiences. One of the best types of training that can be given the child is that of perceiving quickly and accurately and of observing particular objects, processes, and events with the intention of gaining information necessary for the solution of problems or the execution of projects. How this type of training is accomplished has already been suggested. The value of this type of training is that it furnishes the child with a background for imagery. Nothing can be imagined the elements of which have not been experienced. It is clear, then, that the child's basic need is first-hand contact with the materials that he is expected to use in his thinking. (4)

Experience and Invention

Even adults capable of doing creative thinking of the highest order do not go far beyond their immediate experience. Each of the great inventions originated by such persons, for instance, first came into existence either by accident or in very crude form; and the crude forms were similar to things strikingly familiar to the inventor. Consider the first cotton gin, the first steam engine, the first steamboat, or the first automobile,

for example; each is very similar to the thing the invention was designed to replace. Then came improvements in the form of additions and subtractions until the final product has little resemblance to the original. Though improvements have been made at different times, and often one by one, and by different individuals, each is usually only slightly different from the preceding one. In brief, every article that we now have that has appeared as an invention by some person of creative genius has a history back of it, and its history reveals a gradual evolution from the very crude form to the finished product. All of this indicates, of course, that creative thinking is based on the first-hand experiences of the thinker, and this fact indicates that all thinking proceeds from the known to the unknown. Thus, if the child is introduced to an unknown fact, steps must be taken to supply the concrete experiences necessary for understanding and appreciating it. Otherwise, what is fact to the older and wiser is a jumble of words to the young learner.

Practice in Reviving Images

In Drawing

Opportunities for reviving images of actual experiences can be provided in each subject, but particularly in drawing and composition. Drawing, and especially copy work, as we have seen, is helpful in developing accurate percepts. Reproductive imagination is stimulated and improved by drawing objects from memory. This type of activity focuses attention on memory images and reveals their usual haziness; and the requirement to draw from memory tends to stimulate accurate observation of the objects the learner suspects he may be called upon to draw. Much valuable help can be given by requiring children to label carefully the various parts of drawings and to describe carefully the objects the drawings represent. This procedure helps to form associations between particular images and ideas and to increase the learner's range of descriptive symbols. (10)

In Composition

Composition work is profitable in developing reproductive imagination when the learner is asked to write out accurate

descriptions of things, directions for doing things, etc. The things he describes or tells how to make, of course, should be those which he has had or may have an opportunity to observe. In this type of activity, the child's tendency to exaggerate or to fill the gaps of his faulty imagery with other inaccurate notions and fancies can be gradually overcome, especially if his offering is presented to other pupils for criticism and correction. Any exercise, in composition or any other subject, designed to prompt the individual to reproduce his experiences in fairly accurate form, is calculated to improve the reproductive function of the mind. And the training of this function has the tendency to curb the relatively useless productive imagination involved in relating extraordinary achievements.

Language and Imagination

Mutual Dependence

Were it not for language, imaginary processes would be relatively meaningless and poorly directed; for language symbols serve as unifying factors of imaginary processes. Through associative processes, language symbols, words and expressions get connected with images and images with language symbols, so that one will revive the other. The result is a substitution of language for images and of images for language in thought, and the consequent attachment of definite meanings to each thought process. In other words, an image comes to have meaning, not only in terms of other images that may appear in consciousness with it, but also in terms of the ideas that are associated with it; and as one increases the number of such associations, he increases his ability to think about a given image or object. Images may thus stimulate ideas or language forms to appear in thought, and language forms may stimulate the appearance of images. One of the teacher's tasks in training the child to imagine is that of directing the formation of definite associations between the language symbols and the images they represent. (10)

Imagination in Reading

The associations indicated are made most effectively in beginning reading. Here the child needs more than the verbaliza-

tion of the words he is taught. He needs to be presented, in addition, with actual objects, pictures, sounds, and even tastes and smells, when appropriate, in connection with the various words, and to act out those words that refer to muscular behavior. A picture which illustrates a story, or an action performed in compliance with a printed command gives the child a definite experience which not only enriches the meaning of the word but which also serves as a background for concrete imagery. When he is trained to read by associating objects and symbols of objects with words which represent them, the child is prepared to construct the picture or action suggested in his reading lesson.

In forming such associations, the teacher may rely upon the principles of association described in connection with associative learning. Here, however, emphasis should be placed upon a different type of association. The formation of such associations is a splendid means of preparing the child to think in terms of verbal imagery and thus eventually to do abstract thinking.

Making Imagination Conform to Reality: Through Geography

Since children have little regard for truth or reality when they imagine, they must be trained to control their flights of imagination. This can be done by making them aware of the little value their fanciful creations have in adjusting to the world about them, and by acquainting them, as far as possible with the nature of the real world. This is done mainly in the teaching of geography and history.

Geography and Imagination

The subject of geography has for its definite purpose the acquainting of the child with his natural and social world. The earth with its land and water, rivers and lakes, plants and animals, peoples of every kind; the heavens above with the sun, moon, and the stars; the seasons—the rain, the lightning, the thunder, and the clouds and the storm; the peoples of far-away lands—all of these things that have been thought of in story, fancy, or myth must be made real. The child must conceive these and many other things in their proper relations, and be made to understand how he is related to them. He must know them all in a much broader sense than he can ever perceive

them, and when he comes to know them in their true nature, he can never again believe the stories that have been so absorbingly interesting to him in the past.

The learning of geography involves imagination because it deals with things that the learner can never experience in perceptual form. He might perceive some aspects of the things geography treats, but not in the sense that he must come to know them. He may perceive the sun, know what it is, and recognize it as a source of light and heat; but it requires a complete act of imagination to *conceive* it as a mighty mass thousands of miles in diameter and millions of miles away. The child might perceive various features of the earth, but from what he can see, he could never think of it as a huge mass, round like a ball, and held in space by unseen forces in certain relationship to the sun. In order to conceive this, he must not only imagine, but he must make his imagination conform with a great number of important facts. So it is with all the various matters dealt with in geography; they nearly all lie beyond the range of the senses and must be known through the learner's ability to construct and produce objects, events, relationships, and processes out of the elements of his own experiences. Thus, among all the school subjects, geography is the one that brings the child out of the realm of fancy to the real world; and it makes such huge demands upon his imaginary processes that the fairy world is left meaningless and insignificant, except as idle fancy. (10)

How to Make Imagination Function in Geography

It would take us too far afield to discuss methods of teaching geography, but a few practical suggestions are in order. It is already apparent that teachers should not be satisfied with the child's performance when he is able merely to answer the questions at the end of a chapter in the textbook. The actual learning involved in this performance may be little better than rote memory. The teacher should furnish the child a wealth of concrete experiences with which to construct the objects and events with which geography deals. These experiences may be gained in a variety of ways. The teacher may take the pupils on frequent excursions to field and forest, river or lake, zoo or circus, farm or city—to factories, foundries, power plants, ice factories, flouring mills, paper mills, printing offices,

back yards, shipping docks, gas-works, railroad depots, law courts, etc. Here the child gains first-hand contact with many things about which he studies. The school museum or a state or national museum may be visited, where the teacher should point out and explain the things of most value and significance. When it is impossible to visit, the pupils may be encouraged to secure specimens of various things—stamps, insects, animals, and raw products of all kinds. The class may even construct models of objects described—of the earth, of a city, a ship, etc. Objects from different countries are particularly helpful. All these perceptual experiences and the notions derived from them should then be interpreted and explained in terms of the textbooks.

Use of Symbols in Geography

The teacher will also need to make considerable use of symbols, and the pupil must have some training in order to interpret them. Young children at first may know less about the symbol than they know about the thing symbolized. With regard to pictures, pupils may fail to perceive perspective, the relative size of various objects, to notice colors, or to understand the meaning of shades and shadows. The young child is known to see pictures only in a perceptual way; he may recognize the objects but fail to interpret the story that is told. A map or globe, on the other hand, is little more than lines and splotches of color arranged in odd patterns; and charts, diagrams, graphs, and other complicated symbols are usually regarded with very little interest, even by many high-school and college students. When symbols are regarded in these ways, their use may be a waste of time. (10)

How to Make Symbols Meaningful

In order to make the most effective use of symbols in training pupils to interpret them, the teacher needs a projection lantern that will project pictures from slides and also from the textbooks or other sources, and a well-selected set of slides or pictures for each unit of material. These should be projected, studied, interpreted, and applied to specific facts and principles. Each picture should be chosen to represent only one significant fact. but it should have the power of suggestion for various

other facts. The teacher should not only point out the parts of the picture which illustrate this or that, but she should also indicate the manner in which pictures in general are interpreted, the significance of perception, size of objects, colors, etc.

One of the best ways to teach perspective is by means of stereoscopic study. The stereoscope involves the principle of binocular vision, which enables one to see a picture in much the same way that he sees an actual scene. The pictures are taken with a camera with two lenses separated by a distance approximately equal to the distance between the two eyes, and this arrangement gives two slightly different views of the same object. These are looked at through two lenticular prisms, one for each eye, as that eye views one picture and the other views another. Both views, being seen at the same time, give the effect of one scene, and this scene presents a most striking illusion of depth and solidity. The scenes appear to the individual as if he were actually looking at them. Practice in viewing scenes in this way not only gives additional information but tends to induce the child to add perspective to flat pictures when he looks at them, especially if he is furnished stereoscopic views of the same scenes as those exhibited in flat pictures. Some commercial concerns furnish sets of slides and stereographs of scenes for use in geography teaching; and these have proved to be invaluable aids to many teachers.

The best way to teach the child the meaning of maps, globes, charts, diagrams, and the like, is to have him make them. Let the class in elementary geography for example, make a map of the classroom, school ground, and surrounding community, drawing each to scale and showing the location of each object on it. This type of practice will acquaint the pupil with the essential features of the maps used to represent larger areas and the location of such things as cities, rivers, and mountains. Map-drawing of the copying or tracing type is of very little value until the pupil has learned what maps are for and how to interpret the lines, scales, numbers, etc., used in map construction. After he has learned to appreciate the meaning of these symbols through making maps of spaces and objects with which he is familiar, the pupil is better prepared to appreciate the symbols of things with which he is unfamiliar. The understanding and appreciation of other pictorial or graphic aids

than maps can be developed by similar procedures. In dealing with such things, however, the teacher must not let the pupil lose sight of the purpose for which they are used. The means should not become the end. In his drawing of a map, for example, the child should realize that a map symbolizes a country and that it is not something apart from this. If the teacher makes sure that she is stressing the realities more than the symbols, the use of symbols is a valuable aid to all teaching.

History and Imagination

Imaginary Features of History

The world of today is largely a product of the world of the past, and the better one understands the past the better he may understand the conditions and circumstances of the present. Thus, a second subject intended to give pupils a better understanding of the world in which they live is *history*. This subject involves imagination in that it deals with things of the past which the pupil can never experience directly; with objects, persons, events, and processes beyond perception in both time, and place. The purpose of the historian, however, is to present word pictures of these things so that pupils can construct and produce them mentally, and thus gain an understanding of them and their relation to present conditions and problems. How well the child does this depends upon the range of his personal experiences and his ability to guide his imaginary processes to meet the requirements of the historian.

Why History Is Difficult

The chief difficulties encountered by children in the study of history are due to two things: (a) their limited appreciation of time intervals, and (b) their inability to divest their minds of images of things they already know. Complete understanding of history involves, of course, placing events in time order, and in this, most children are markedly deficient. The child is usually six years old before he knows the meaning of morning and afternoon; and he is twelve to thirteen before he appreciates the significance of days of the month, at least to the extent of knowing the date. Until he reaches this stage of development, the dates recorded in history have little, if any, signifi-

cance for the average child, even though he may memorize all of them. It is also apparent that few children are able to appreciate long lapses of time.

How Major Difficulties Are Overcome

The difficulties due to the lack of "time sense" are overcome, in part, by beginning with comparatively recent history and passing from that to more remote history. The child should not begin the study of formal history, for example, with the life of primitive man, but with the history of his own state or country. He might even begin with a study of his family history, as far as his parents or others can inform him of it. In fairly recent history, the lapses of time are not too great for the child to grasp something of their meaning. The teacher can help the child appreciate long lapses of time, to some extent, by presenting dates on a scale, letting a certain unit of space represent so many years. A kind of diagram made up of important dates and events that occurred on them will help the child see time relations, especially if some familiar lapse of time, such as a child's age, appears on the diagram. (10)

Beginning History

The foundations of history can be laid in the reading and language classes through stories based on the lives of great men. This type of thing may be done as early as the second or third grade. The stories, as far as history is concerned, should aim at nothing more, however, than acquainting the children with the names of historical characters and with some of their admirable traits. The time element in these stories is unimportant; a given story may begin as well with "Once upon a time" as with a definite date. Efforts to give the child of this age a background for history through the study of primitive man, as has been advocated by some, have little more effect on historical development than does the telling of fairy stories.

Apperception in History

The difficulties due to the inability of the child to divest his mind of things he knows today are apparent in the way children think and talk about historical events. Upon being told of persons who lived in the past, the child has a strong

tendency to think of them as living like the people with whom he is familiar—as being surrounded with the many inventions, luxuries, and conveniences in use at the present time. This is a natural thing to do, as the child tends to think of things in terms of his personal experiences. Because of this, he often transfers the people he knows, together with the scenes he understands, to the story which history relates and then he thinks of all these in terms of the story. It is particularly difficult for a child to appreciate the differences in beliefs and mental attitudes of peoples of the past and of those that live now.

Laboratory Study of History

In order to overcome difficulties of this kind, the teacher needs to make use of much concrete material that it is usually possible to secure. Much of the material used in geography, of course, can be used in history. In addition, mention may be made of historical movies, relics, and heirlooms, pictures, museums, excursions to historic places, pageants, and the like. The teacher and pupils, in fact, may assemble from time to time a sufficient number of objects of this type to serve as a background for reconstructing a large variety of historic events. Dramatization is a type of pupil activity that pupils enjoy and from which they derive much historic insight. A *social science laboratory* may be the outcome of the search for suitable material by both teachers and pupils, and to it the pupils can be taken when studying any particular unit in history. The idea of all such aids is to furnish the pupils with sense impressions by which they construct persons, places, customs, events, and developments that have characterized the past in different parts of the world. This type of procedure prevents the pupils from approaching the study of history as a body of material that must be memorized. (1)

Credulity, Truth, and Falsehood

Transition from Credulity to Doubt

The hazy conception of the world about him will be overcome to a large extent through the study of such subjects as history and geography, but the child will continue to experience difficulties in distinguishing between truth and falsehood. The

reason for this is that children have incomplete standards by which to detect error. The only standards they have at first are conditioned responses to language stimuli and habits by which their actions have been brought under parental control. This process has the tendency to cause children to accept as true whatever their parents tell them. Gradually, of course, the young child discovers numerous errors, inconsistencies, and contradictions in what he is told; and he eventually learns that his parents are not all-wise and all-powerful, as he has formerly believed. As a result, he becomes conscious of the existence of truth and falsehood, and of the necessity for putting some kind of test to the things he hears.

How Standards of Truth and Falsehood Arise

Perhaps children's earliest discoveries along this line are made in dealing with teasing and joking on the part of others, in which they discover that even the parents do not always "mean what they say." From this time on, the child's behavior often exhibits an effort on his part to determine when and when not to follow a given suggestion. As a basis for making his decision, he depends at first on perception of facial expressions, tone of voice, bodily postures, and the like, which reflect the approval or disapproval of the parents. Through constant observation of those who attempt to control his actions, the child soon learns when and when not to do as he is told. When convinced of the sincerity of parents, or that their tolerance has reached the saturation point in a given instance, the well-trained child usually conforms to their demands.

During this period of training, however, the child starts to school, where he meets a new voice of authority in the teacher, and witnesses a great variety of contradictions among the pupils. When he is blocked by other children from doing as he wishes, and when he sees that the teacher is there to adjust differences, the child quickly recognizes the teacher as an authority in the school situation. In the contacts with other children, the child not only suffers interference in his behavior, but he also gets into a variety of wrangles and disputes. These, like his behavior problems, are taken to the teachers or parents for final settlement. There the child discovers the existence of truth and falsehood and a certain group of persons whose every word

is accepted as the final standard of truth. "Teacher says," "My daddy says," "Mother says," and similar expressions are complete proof for the normal child, and whatever statements contradict these are false.

Parental Guidance in Case of Early Conflicts

In the settlement of differences among children, parents and teachers have their best opportunities for moral and spiritual guidance and for the molding of ethical conduct. In order to achieve this result, however, they should analyze carefully each difficulty or problem presented, and attempt to show each child where he is correct and where he is at fault and why. Whatever facts or principles the parent or teacher relies upon should be drawn, as far as possible, from the children's own experiences. References may be made at times to stories or historical content as a basis for reaching decisions, the effort here being to transfer eventually the child's standards to a still higher source of authority than the parent or teacher. Whatever the explanation, it should be clear and concise, and it should cover adequately the case at hand. Each child should realize, in particular, that the disposition of the case has been fair and unprejudiced.

The confidence and trust that children have in their parents and teachers last until the beginning of later childhood. From this time on children are able to recognize many weaknesses and shortcomings in those they have formerly trusted completely. This change occurs when children begin to discover the falseness of many of the things they have been told. In one way or another they begin to find out about the mysteries of birth, sex, maturity, paternity, and the like. The natures of the stork, doctor, Santa Claus, bogy man, and various other mysteries clear up; and the discoveries are often made before parents realize that they are taking place. In most cases, especially among children associated with others younger than themselves, these revelations occur and have few harmful consequences. In many cases, however, children feel that some truth is kept from them, and they often grow morbid and suspicious. This is especially true of children whose parents or teachers continue to use the old evasions, and refuse to furnish explanations in terms of the children's stage of development. Many

authorities emphasize the idea that children should have full and complete explanations in terms of the facts when they express a deep concern in knowing about such things as their origin and the relationship between the parents. It seems proper, then, that the parents should be the first to reveal the nature of the things that appear mysterious to the child, and that the teacher should be prepared to answer questions in a straightforward manner.

Guidance in School

Many parents and teachers make the unfortunate mistake of trying to hide or conceal their ignorance. This is an unfortunate mistake, because it tends to emphasize a growing suspicion on the part of the child. Children are quick to detect evasions, and many are somewhat adroit in increasing the evader's embarrassment. A better procedure than evasion is admission of the lack of knowledge and citation of various sources of such information. Since children are already discovering many of the misgivings of their elders, there is no harm in letting them discover a lack of information. Teachers, in particular, should be ready to admit lack of information and to cite the sources of such information, and thus to take the child to better and higher authorities than themselves. This step has a tendency to emphasize the textbooks as authorities, especially biography, history, geography, and the various books on science. Here the child may discover the teacher's source of information and come to realize that no one can know everything. Eventually, with the proper training, one discovers various inconsistencies among books and comes to realize that mankind in general is still busy with the task of trying to understand a complex world.

By the time children reach the stage of adolescence, they begin to search for a philosophy of life by which they can harmonize the inconsistencies they know exist. They begin to recognize the need of standards of conduct by which they can measure the wisdom or folly of various acts. Most of them discover such standards in existing creeds or codes, and become more or less settled in their attitudes toward the things of life in general. In religion this period is marked by the processes of conversion, through which the child is made to feel

satisfied with the acceptance of a particular creed or group of formulations. Many young people, however, undergo many intellectual struggles with the formulations that satisfy the masses, and they continue to experience confusion until far into the stage of youth. This is especially the case when they come in contact with teachers who attempt to change the individual's accepted formulations and standards. Some of these young people adopt some daring or radical philosophy, such as anarchism, agnosticism, etc.

Improvement of Creative Imagination

Meaning and Functions

Creative imagination is a kind of productive imagination in which the images involved are carefully selected and rejected in terms of a particular problem or goal that is new or novel to the individual. The young boy employs one kind of productive imagination when he attempts to escape from reality as a "conquering hero"; but he employs the creative type when he gets together tools and materials and makes a new kind of kite. Here the boy employs ability to foresee the final result of his own activities and of the combinations of images of various objects and processes. Creative imagination is, therefore, the chief characteristic of the type of thinking involved in planning, anticipating, making preparations for, and carrying out a specially designed project. (4)

Development of Creative Imagination

This type of imagination is characteristic of individuals at all ages, though it may appear in very crude forms. It begins in infancy, perhaps, when the infant tries out various schemes, such as using different kinds of cries to attract mother's attention. It is surely present in crude form in the baby who pushes, throws, breaks, tears, and strikes things to see what will happen, or to make a given thing happen. It is certainly present in the play of children who make things out of their blocks, or who try out new games of many different kinds; and in the adolescent who gets together the large variety of paraphernalia necessary to make a "fire engine." At all stages, in fact, man exhibits a creative tendency that needs developing,

a kind of ability to see beyond the things that are already known to him.

Individual Differences in Creative Imagination

While everyone employs creative imagination to some extent, some are able to use it more effectively than others. Some persons seem to be almost void of ability to recombine their experiences in such a way as to solve a new problem or succeed in a new undertaking. These have to be shown, trained, and taught before they "catch on." After having been taught or trained to do various things, they can plan and execute a few new undertakings. Other persons are quick to see the nature and importance of new discoveries and to appropriate them for their own uses; but they may not succeed in making any new discoveries that will startle the world. Still others are able to work out many new projects and to make various contributions to the knowledge and material equipment of society at large. From another point of view, some individuals live on the plane of instinct and habit; others collect facts and accumulate knowledge; and still others make great discoveries. To the first group belong the laborers, to the second the practical and professional men, to the third the men of art, letters, and science. (4)

The differences here are due, in part, to native ability or intelligence, but largely to the manner in which individuals are motivated and trained. The individual who can create is one who has been trained (a) to perceive clearly and accurately; (b) to construct imagery described or suggested by others; (c) to apply his own imagery to the solution of a great variety of problems and projects whose immediate solution is not understood; and (d) to attempt what appears at the present to be impossible of realization. In other words, creative imagination is a highly trained type of thinking in which the individual is strongly motivated to overcome all obstacles.

Creative Thinking in School

Although the teacher may not succeed in making geniuses of her pupils, she should provide ample opportunities for children to do what they can at this or that type of original work. Whether she urges them to write poetry or short stories, make machinery, design clothing or posters, discover remedies

for civic backwardness, print a newspaper, or undertake any other type of project, the teacher should inspire and encourage children to do the creative thing. Too many teachers hamper the creative tendency in children by holding them to formal exercises or to the mastery of textbook information. In manual training, for example, a boy may be prevented from exhibiting creative ability by being required to do little exercises that he learned to do in his own workshop at home. Formal exercises are good for teaching the essentials to the unskilled, but the child who has the technique should be permitted to try something new. A child who exhibits ease and alertness in the mastery of the facts contained in the textbooks should be permitted and encouraged to utilize the information acquired here and elsewhere in working out his own projects. His final product may not be an invention that will add to the world's stock of knowledge or material equipment, but the training the child receives in working it out will doubtless prepare him for a greater and more profitable undertaking. Within the past few years, the public schools have given considerable attention to this type of development, and every teacher should come to appreciate its importance.

EXERCISES

1. What are the elements or factors that enable human beings to imagine? Make a list of as many as you can.
2. Criticize the distinctions made in the text between imaging, imagery, and imagination; and between the various types of imagination. Are such distinctions based on objective or subjective data? Discuss.
3. Present arguments sustaining the theory that imaginary processes are products of sensory rather than cerebral processes.
4. Discuss the function of language in imagination.
5. Write a paper on the *imagination of children*, pointing out the changes that occur with an increase in age.
6. In what ways is the process of imagination highly important in thinking and acting?
7. What does training imagination involve?
8. What school subjects appear to be best suited to training imagination? State the values of each subject in this respect.
9. Give original examples of childish credulity which should be rapidly overcome.
10. Why do children often fail to grasp the meaning and significance of symbols? How may this difficulty in their thinking be overcome?

11. To what extent do imaginary processes determine the moral concepts of children? How?
12. Discuss the dangers on the part of children of substituting imaginary for real achievement. At what ages is such practice likely to arise?
13. How does creative imagination differ from productive imagination?
14. How should teachers attempt to train pupils to do creative thinking?

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PART IV

MEASUREMENT IN EDUCATIONAL PSYCHOLOGY

Purpose of Part IV

General Problems

The purpose of this section of the text is to present a brief survey of the field of measurement in educational psychology. In order to do this, we shall cite examples of different types of measurements and the uses and values of each type in solving various problems. Then we shall present some typical results of the different types of measurements and show how these results are dealt with in teaching. Finally, we shall study some of the operations involved in the statistical treatment of data or scores derived by measurements.

Limitations

The purpose in presenting a treatment of measurement is not to train students in the use of measuring devices but only to make them aware of the specific ways in which human traits are evaluated. Moreover, it is not the purpose here to deal with each type of measurement in a detailed manner, but to make the student aware of the special ways of determining the amounts of the various traits that have been discussed in the preceding sections. Furthermore, we are not dealing with the history of the development of measurements. Although this is an interesting and profitable subject of investigation, we shall have to confine our discussion here to the types of measurements in existence at the present time.

Definitions of Terms

Measurement

The term "measurement" has two meanings: (a) It describes the science of devising, constructing, applying, and interpreting the results of *tests* and *scales* designed to secure quantitative

values or scores that represent the magnitude, extent, or amount of human traits. (b) It refers to the application of tests and scales to human subjects. We study the *science* of *measurement* to get acquainted with measuring instruments and their uses and results; we engage in measuring when we actually apply the instruments of the science to human subjects.

Test

The term *test*, as used above, denotes any routine or prescribed method of determining the amount of a given trait or set of traits. In some instances, the term is used to denote the procedure followed; in other instances, the term is used to denote the devices or instruments employed. When mechanical instruments are employed as measuring devices, the term "test" refers to the routine method of using the apparatus and handling the subject; when a paper booklet containing questions, problems, and exercises is employed, the term "test" refers to this booklet or set of questions. The procedure or method in the latter case is described as *administering the test*. In either case, the procedure and instrument may have been *standardized;* so that the tester may proceed in an exact, precise manner, and require his subject to act or perform in accordance with precise instructions. Otherwise, the results of scores obtained by a test when used by different examiners have little or no value. A test that is given in accordance with specific instructions and that has been previously evaluated by giving it to numerous subjects is called a *standardized test*.

Scale

The term *scale* is likewise used with two meanings: First, it is used to denote a series of standard values, usually represented by group averages of scores or measures derived by a given test, by which the amount of a trait or set of traits in a given individual, of a given age or grade, may be evaluated. A scale is made by taking a large number of measures of different individuals at successive ages, averaging the measures for each age, and arranging the measures in the order of their magnitude. When a single measure is secured from a certain individual, it can then be evaluated by comparing it with the averages for his age or grade. Group averages, which represent successive

points on the scale, are usually called *norms*. Sometimes a *table of norms* serves as a scale by which to evaluate individual scores.

Secondly, the term *scale* is used to denote a test, or series of tests, in which the items (questions, problems, and exercises) are arranged in the order of increasing difficulty and according to the pupil's age. In a scale, in this sense, the first items are designed for the youngest subjects, the next for a higher age, etc., so that it is possible to measure the limit of a given trait in each individual and to determine whether or not the trait is at, above, or below the normal. The latter is done, of course, by comparing the individual's score with a table of norms, or by locating the position of his score on the scale of measures.

Sampling

The norms or averages on a scale derived from a given measuring instrument are supposed to represent all of the individuals of each of several ages or grades. They are determined, therefore, by applying the test to as many persons of each age, or grade, as is practicable. It would be impracticable, of course, to apply a test to every person of a given age. For this reason, it is customary, in establishing norms, to select at random a limited number of individuals out of an entire group or population, and let these represent the whole group. When the number is taken at random, i.e., without preference or regard to any characteristic, it is assumed that the group selected represents the total population from which it is taken. This group constitutes a *sampling* of the population. When the individuals in this group possess all amounts of a given trait possessed by the larger group, the sampling is *adequate*. If the smaller group fails to represent the larger, the sampling is inadequate; an *error of sampling* has been made. A sampling is usually adequate if the group actually measured is very large, and it is usually inadequate if the group is small.

Variation

The need of prescribed methods of measuring, of tests and scales, and of adequate samplings, etc., is due to the variation of traits. By *variation* is meant the extent to which human traits differ among individuals. When any trait is selected for

special study, it is found to vary, for instance, in two directions: (a) it varies from one time to another, as from year to year, particularly in growing children; and (b) it varies in character and amount in different individuals. Intelligence, for example, increases steadily with age up to maturity; and it varies in different individuals of the same or different ages, from nearly none at all in the idiot to a relatively large amount in the genius. Thus, in measuring particular traits, or sets of traits, there is a need for measuring devices suited to individuals of different ages, and there is also a need for norms by which one individual may be compared to or contrasted with another or with a group.

Types of Measurements

Human traits exhibit such a high degree of variability, in kind and amount, that the number of specific measuring devices and techniques is almost unlimited. Consequently, there are various ways of classifying measurements. Perhaps the most comprehensive view of measurements may be gained by presenting them in types named according to the types of traits discussed in the previous sections of this text. When they are classified on this basis, we find the following types: (a) physical tests, or anthropometric measurements; (b) sensory tests, or psycho-physical measurements; (c) simple motor tests; (d) tests of physical condition and ability; (e) motor ability tests; (f) tests of specific mental functions and abilities, including primary affective states and specific mental capacities; (g) tests of general mental ability and special aptitudes; and (h) tests of educational products. In the discussion that follows, one chapter will be devoted to the first five types, and a separate chapter to each of the other types indicated. An effort will be made to show how numerous traits are measured and some of the uses and values of specific types of measurements.

CHAPTER XVII

PHYSICAL, SENSORY, AND MOTOR TESTS

INTRODUCTION

Purpose of the Chapter

This chapter will deal with the techniques and methods of measuring physical traits, relatively simple sensory and motor functions and capacities, and motor ability, and with some of the uses and values of each of these types. This group is concerned mainly with determining the amounts of inherited traits.

TESTS OF PHYSICAL TRAITS: ANTHROPOMETRIC MEASUREMENTS

Meaning and Scope

Meaning

By anthropometric measurements is meant a variety of tests or methods of determining bodily size, dimensions, shape, posture, and proportion. The tests employed include numerous special ways of measuring height, weight, length, growth, and width or breadth of the body and of its various parts. As a field of study, this group of tests and their application and treatment of results is known as the *science of anthropometry.*

Scope

Anthropometric measurements are employed in a number of arts and sciences. They are used in painting and sculpture as a means of discovering ideal sizes and proportions of bodily parts of individuals of different types. They are used in biology, anthropology, and sociology as a means of studying differences between individuals, races, and peoples of various types. They are employed in educational psychology and physical education in a variety of ways that will be described later. Such measurements are valuable in any science that has need of information concerning physical traits.

Methods and Techniques of Measuring Physical Traits

Bodily Size

General bodily size is determined mainly by determining (a) standing height, (b) sitting height, and (c) weight. Standing and sitting height are measured by means of a stadiometer, or height stand, which consists of a box-like base to which is attached at the back a graduated upright with a sliding arm. For standing height, the examiner has the subject remove his shoes and stand on the base of the stadiometer with heels together and with heels, buttocks, and head in contact with the upright. The examiner then brings the sliding arm down, lets it rest squarely on the subject's head, and records the reading. For sitting height, the subject sits on the base of the stadiometer with buttocks, spine, and head touching the upright.

Weight may be taken on any accurate scales, but it is preferable to employ scales devised for anthropometric work. These are graduated in units of the metric system and the weights are quickly and easily read. Some anthropometric scales are equipped with an attachment for taking height. This consists of a graduated rod with an arm that can be raised or lowered. This type of scales enables the worker to take standing and sitting height and weight on the same instrument.

The general purpose of the three tests is to furnish indices of bodily size and growth which may be compared with mental traits and other physical traits. Norms of these tests for both boys and girls of different ages are available. They consist of averages derived from measures of hundreds of individuals of different ages. A sample of such norms is presented in Chapter IV. This sample shows the average height and gain in weight of boys and girls at successive ages.

Height and weight measures have been compared with measures of many other traits including race, sex, occupation, order of birth, locality, progress in school work, intelligence, various abnormalities, numerous motor abilities, and various other factors and traits. It has been found, generally, that Americans are larger than foreign-born persons in the United States; that first-born are larger than those later born; that boys are larger and continue their growth longer than girls; that children of the non-laboring class are larger than those of the laboring

class; that bright children who excel in school work are larger than the dull laggards; and that larger children excel in strength and motor abilities. In most cases, however, the differences are slight and fluctuating; so that measures of size are not reliable indices of other traits. (9)

Arm, Hip, and Chest Measures

Three additional measures that have come into prominence recently are the girth of the upper arms, thickness of the chest, and the width of the hips. The first is taken with an anthropometric tape, with the arm flexed and extended; and the other two are taken with a special calipers. When taken together, the measures are known as the *ACH index of nutrition* and has been found useful, in connection with height and weight, as an index of the nutritional status of young children. The measures are used, therefore, to discover children who are undernourished, and who not only show a disposition to do poor school work but who also exhibit tendencies toward various diseases and emotional disturbances.

Head Measurements

Considerable interest has been manifested in various head or skull measurements. These include the length and width and circumference of the head, the first two being made with a special head calipers and the third with a tape. These measures have been made largely for the purpose of discovering the relation of head dimensions to mental abilities. The ratio of the length to the width of the head is called the *cephalic index*, which has been compared with various measures of intelligence. While there is some evidence that shows a slight correspondence between head size and mental ability, the correspondence is too slight to be of any great value in attempting to determine mental ability by taking head dimensions. The results of comparisons of head circumferences with measures of intelligence indicate that children having small heads exhibit, in general, a tendency to do poorer school work and to have less intelligence than children who have large heads. Having a large head however, is not an indication of a high degree of intelligence. Nevertheless, according to available data, having an extremely small head is a fair index to a low degree of intelligence. (9)

Other Physical Measurements

In addition to the measures just described there are various others that have been found useful in certain fields of study. These are: girth of the chest (reposed and full), waist, hips, thighs, knees, calves, insteps, forearms, and wrists; depth of the chest and abdomen; breadth of the neck, shoulders, and waist; length of the limbs and parts thereof; and stretch of the arms. Many such measures have been made to determine norms for each. The norms, in turn, together with those of the measures described above, have been used to construct *anthropometric charts* showing the measures of a typical individual of either sex. In some schools, such charts are on display so that a pupil may compare his own chart with the typical or ideal and thus discover to what extent he varies from it. A chart is made by listing the names of the measures along the vertical axis of cross section paper and locating points opposite the names at such a distance on the horizontal axis that these points will represent the measure of the traits. By comparing his own chart with one based on averages, a pupil is able to discover the extent to which he varies from the typical pupil of his age. Such charts usually exhibit other measures also, such as strength of the lungs, back, legs, chest, upper arms and forearms, and amount of vision and audition.

These additional measures and charts are used mainly in physical education, where they have their chief values. Many practices in this field, at least, have been based on discoveries made by studying the results of anthropometric measurements. The taking of measurements has been prompted largely by the desire, on the part of workers in the field, to discover facts on the basis of which they can tell each pupil what constitutes an ideal or typical individual, what his deficiencies are, and how his best development can be brought about.

Instead of going to the trouble and expense of taking many particular measures, many workers in the field of physical education depend upon facts revealed by *silhouettes*. These are pictures showing the contour of the body in white or black on a solid background of the opposite color. The silhouette is taken by a special camera, and with the subject standing in front of a screen graduated in inches. In this way it is possible to read

various bodily dimensions and to observe the individual's posture and proportions directly from the picture. These silhouettegraphs, as they are called, are often used as a convenient and relatively inexpensive substitute for anthropometric charts. The graphs are useful in determining length and width of body parts, as well as posture and proportions; but they cannot be used in taking diameters of various portions of the body. (2)

All such measures, we may say in passing, should be made as accurately as possible. The examiner should proceed according to standard instruments, otherwise, the particular measures that he secures are practically useless. They cannot be compared, at least, with the norms and charts which have already been established.

TESTS OF SENSORY CAPACITIES

Meaning, Types, and Scope

Meaning and Types

Measuring instruments of sensory capacities include a wide range of tests designed to determine the amount, extent, and magnitude of sensation and perception resulting from different degrees of stimulus intensity. The complete group of tests may be divided into two types: (a) tests of visual, auditory, and tactual acuity or sensitivity; and (b) tests of visual, auditory, and tactual discrimination. The first type of tests is used to determine *sensory limens*, or the smallest amounts of stimuli that may be sensed or perceived; and the second type is used to determine *difference limens*, or just noticeable differences (J.N.Ds.) between pairs of stimuli presented contiguously, such as shades of gray, tones of different pitches, shades of red, etc. Either type of test can be applied to any sense organ and to various attributes of sensations, such as quality, intensity, extent, and duration. In measuring visual sensitivity, for example, we may determine the range of colors to which an individual is sensitive, the least amount of color to which he is sensitive (limen), the size or extent of the stimulus, and the duration of time a given stimulus is effective without change. We may also measure the differences between any of these attributes when two stimuli are presented and compared, such as the difference between the qualities of two similar colors, the differ-

ence in time two stimuli are effective, or the difference between two weights. (6)

Scope of the Field

The possibilities of making measurements in this field, as well as the great variety of tests that have been devised, are almost unlimited. In the field of vision alone, there are numerous ways of testing visual acuity, a great variety of ways of measuring color perception and discrimination, and many tests of visual defects. In the field of hearing, there are many special types of sensation and their attributes such as pitch, duration, intensity, and quality of tones, which may be measured in a variety of ways. The same is true of any other sense, though some sensory capacities and the attributes of certain types of sensations are not as readily measured as are others.

The scope of the field of measurement of sensory processes is so large, in fact, that there is a large body of literature dealing with its different measurements and their results. This body of material is usually designated as *psycho-physics*, so called because it deals with physical forces and realities as much as it deals with psychical or mental phenomena. Most of this material, however, is of primary interest to the psychologist rather than to the educational psychologist, and for this reason we shall give attention to only a small number of tests. These are the tests of visual and auditory acuity and perception by which particular defects are discovered. Such capacities and incapacities as these are of fundamental interest to all educators. (6, 9)

Description of Visual Defects

Types of Defects

Visual defects are of three general types: (a) ametropia, (b) imbalance, and (c) color-blindness. *Ametropia* is any refractive defect of the eyeball, lens, or cornea. *Muscular imbalance* is weakness or imperfect control of the muscles of the eyes which renders them incapable of working together properly. *Color-blindness* is the inability to sense colors. There are several forms of each of these.

Ametropia exists in the following forms: (a) *myopia*, or near-

sightedness, commonly produced by too long an eyeball which causes rays of light from distant objects to focus in front of the retina; (b) *hyperopia*, or far-sightedness, produced by too short an eyeball, which causes light rays to focus behind the retina when accommodation is relaxed, and produce a blurred image; and (c) *astigmatism*, produced by uneven curvature, usually of the cornea but also of the lens, which results in a double-focused image upon the retina. All three or any two of these defects may exist in combination. The most common combination is astigmatism and hyperopia. Moreover, the defects of one eye may be different from those of the other.

Muscular imbalance includes three forms: (a) *esophoria*, a tendency of the eyes to cross, so that when distant objects are viewed the lines of vision of the two eyes tend toward one another instead of proceeding parallel; (b) *exophoria*, a tendency of the lines of vision to bend outward or away from one another; and (c) *hyperphoria*, a tendency of the line of vision of either eye to be above that of the other. Occasionally these defects result in double vision. The sufferer has two separate retinal images, one of which is improperly located on the retina. Such vision may merely annoy the sufferer, or result in severe eye strain. In extreme form such a condition is known as *strabismus* (cross eyes) or squint.

There are three forms of color-blindness: (a) red-green blindness, or inability to sense and consequently to perceive, reds and greens and their combination; (b) blue-yellow blindness, the inability to sense blues and yellows and their blends; and (c) total color-blindness, or inability to sense any color. The immediate cause of color-blindness is poorly understood and a subject of much dispute. It is thought to be due, however, to a lack of development of the cones, a condition which is inherited. Red-green blindness is found almost entirely in men and in about 4 per cent of the population. Blue-yellow blindness and total blindness are still more rare. (9)

Tests of Visual Defects

Ametropia

The Snellen chart is often used to discover ametropia. It is a white cardboard on which is printed in black a series of letters

and figures of varying sizes and a special arrangement of radiating lines. The letters and figures have been accurately gauged in size to be seen at varying distances by persons of normal vision. The chart is placed in good light and the subject is asked to read the letters or tell the positions of the figures at different distances. The degree of vision of the subject being tested is indicated on the chart by the letters or figures that the subject can read or describe at the prescribed distances. This test will reveal whether the subject is suffering from high degrees of myopia or hyperopia. Astigmatism is measured by asking the subject to observe the radiating lines and to observe whether or not any of the lines is blurred. If the lines are of equal degree of clearness, there is no astigmatism; if some of them are blurred, astigmatism exists. (9)

Muscular Imbalance

This defect of the eyes is usually measured by means of a phorometer. This instrument enables a person to see an object by each of the separate eyes without a fusion of the two images. This is accomplished by means of a pair of cylindrical prisms, one for each eye, which can be rotated so as to bend the line of vision inward or outward in varying amounts. When the prisms are set at zero, and in the horizontal plane, a subject may be asked to look through them at a cross (+). If the eyes of the subject are in perfect balance, he will see two crosses some distance apart but in perfect horizontal alignment, thus + +. If the eyes are out of balance, or imbalanced, the subject will see the crosses out of alignment, maybe thus $+ \; ^{+}$. By rotating the prisms, the tester may make the subject see the crosses in alignment. The amount that the prisms are rotated to get this result indicates the amount of imbalance in the muscles of the eye. By noting which cross is out of line, the tester may know which eye is defective. A similar test is made by setting the prisms at zero in the vertical plane. In this test the two crosses are seen by the person with normal eyes in vertical alignment, thus $\begin{matrix}+\\+\end{matrix}$.

The phorometer can also be used in measuring the relative strength of the eye muscles. This is done by having the subject hold the two crosses in alignment as long as he can, turning

one prism or the other, and noting the amount turned before the subject reports that they are out of alignment. The amount of turn of each prism is determined from a graduated dial each unit of which is called a diopter.

The Betts Test

One of the most elaborate and effective methods of testing vision has been developed recently. It involves the use of an especially constructed stereoscope known as the Ophthalmic-Telebinocular, and a set of cards or slides to be viewed through the instrument. Half of the material on the slides is seen by one eye and half by the other; so that the two halves are fused by the subject having normal vision, producing depth, or what appears to be the third dimension. By varying the kind and arrangement of materials on the slides, it is possible to test the acuity of vision of both eyes and of each eye separately, to measure the ability of the subject, to fuse the visual cues from both eyes, and to determine the extent of vertical and lateral imbalance. A unique feature of this method of testing vision is that each eye may be tested separately while the subject is employing binocular vision, and that many of the different aspects of vision may be tested with respect to different focal distances. The chief value of the method is probably in its simplicity and scope. By following directions carefully and inserting measures in the blanks provided by the makers of the instrument, any well-trained teacher may master the technique in a relatively short period of time. Moreover, when all of the tests have been made, the tester will have relatively accurate measures of many visual defects.

Color-Blindness

There are numerous tests by which color-blindness may be discovered. Two simple methods may be described briefly.

Worsted Test. The worsted test consists in asking the subject to sort out sets of worsted skeins of yarn of various colors and shades. The Holmgren set consists of the following skeins: 100 skeins in reds and greens of different shades, 25 mixed hues of confusion colors, and 40 fundamental colors in equal amounts of red, green, blue, yellow, rose, etc. The test involves having the subject first assort the fundamental colors

and then put the colors of different shades and hues in the separate piles. A person who is color-blind fails to make the proper assortments. A person who has red-green blindness fails to distinguish between these colors, assigning various reds to the pile of greens and various greens to the pile of reds. A person who has blue-yellow blindness confuses these colors in a similar manner.

ISHAHARA'S COLOR PERCEPTION TEST. This test consists of sixteen color plates printed on cardboards and mounted in a book. Each plate contains various hidden figures printed in the fundamental colors, which the color-blind person fails to discover. The type of color-blindness is determined by finding the colors of the figures that the subject is unable to discover, and the degree of blindness is determined by variations in the complexity of the figures in the various plates. (9)

Tests of Hearing

Watch Test

A rough but fairly accurate method of testing hearing is known as the *watch test*. This test consists in determining the distance at which a person can hear the tick of a watch. The subject is seated in a quiet room facing the tester. With a watch in hand, the tester moves away from the subject on a line marked off in half-yards, asking the subject at each half-yard interval if he can hear the tick. When the tester reaches a distance at which the subject barely hears the sound, he records the distance. Then he begins at a point beyond the range of hearing and moves toward the subject until the watch is heard. An average of the two distances represents the point of hearing. By using the same watch and testing a number of subjects, a tester can establish norms with which the hearing of individuals may be compared.

The watch test may be employed by teachers for the purpose of discovering individuals with defective hearing.

Audiometer Tests

A more accurate method of testing hearing is by means of an *audiometer*. This is an instrument designed to produce sounds, such as ticks, tones, or spoken words, of varying degrees of loudness. A subject listens for the sounds and finally reports

the one that is barely heard. The loudness of this sound represents the measure of his hearing.

Though there are several types of audiometers available, the best types for testing the hearing of school children are being manufactured by the Bell Telephone Company, the American Telegraph and Telephone Company, and the Western Electric Company. These companies have recently perfected what they call the 4B and the 6A audiometers.

The 4B audiometer is designed to test groups of persons. It is essentially a phonograph to which has been added telephone apparatus for transmitting sounds produced by the phonograph to the ears of subjects. The phonograph has a magnetic reproducer that picks up these vibrations from records and transforms them into electrical vibrations. These vibrations are changed back to sound vibrations by telephone head-sets, and thus conveyed to the ears. The sounds coming from the records are those of the voice of a man and of a woman calling certain numbers with varying degrees of loudness. Persons being tested put on the head-sets, listed to the numbers, and write in blanks provided on a special score sheet those they hear. From the numbers written, the degree of hearing may be computed. As many as forty processes may be tested at the same time.

The 6B audiometer is used to test individuals. It is a specially constructed oscillator capable of producing sounds of varying degrees of loudness at any frequency ranging from 100 to 10,000 cycles per second. By manipulating a system of dials for varying the loudness and frequency of the sounds, and receiving reports from the subject, a tester can determine not only the degree of hearing but the pitch which the subject hears best. This instrument is used in determining the degree of hearing loss, existence of tonal gaps, and the like. Such a device furnishes valuable information to the otologist in locating nerve lesions and in deciding upon subsequent medical treatment.

Gross Signs of Visual Defects

Signs of Ametropia and Imbalance

An alert teacher may discover visual defects in pupils without the aid of special tests by noticing various gross signs.

The near- or far-sighted child, for example, may hold a book or object an improper distance from his face and may complain frequently of headaches and nausea. Either defect may result in poor school work, especially in reading and in other subjects which require painstaking or constant use of the eyes. Astigmatism is often manifested in nervous tension and emotional instability, especially when it appears in combinations with far-sightedness. Imbalance usually results in marked dislike for reading or for subjects requiring the continuous use of the eyes. It may result in dizziness, nervousness, and indirectly, in nausea.

After discovering any signs of defective vision in her pupils, the teacher should urge them and their parents to consult an oculist. She should also do what she can to relieve eye strain in the classroom. She can do this to a large extent by seeing that light is adequate in amount, and evenly distributed over the desks with a minimum of glare; by providing frequent rest periods in work requiring class vision; by presenting material orally as much as possible; and by placing the pupils in positions having special visual advantages.

Signs of Color-Blindness

Color-blindness is often detected in persons by asking them to tell the colors of objects and then noting their errors. Frequently, color-blind persons will say that a green object and a red object have the same color, particularly when the two colors are of the same intensity. Though such signs are not measures of color-blindness, they indicate its presence.

Causes, Effects, and Gross Signs of Auditory Defects

Auditory defects are found in from 10 to 20 per cent of school children, and about 3 per cent are seriously deaf. About 38 per cent of the auditory defects are inherited, being caused frequently by inter-marriage of near relations. Other defects are caused by inflammations of the ear drum and canals, and by nervous disturbances resulting from such diseases as scarlet fever, measles, brain fever, meningitis, and catarrh of the throat and nose. Hardening of the wax in the outer ear may result in defective hearing, or even in total deafness. The running ear,

caused by an infection of the inner ear, is found in about 2 per cent of school children. This is a serious defect which not only menaces hearing but also produces irritability and frequently a further infection known as mastoiditis.

Defective hearing, like defective vision, is not always readily detected except by highly refined tests, but the teacher may be on the lookout for various signs. Common signs include apparent stupidity, requests for repetition of simple questions, turning of one ear toward a speaker, etc. If a child's partial deafness has existed from early childhood, he may exhibit inability to give proper inflection to words in oral reading, to pronounce words correctly in taking dictation, or to keep up with his work in school in general. A hard-of-hearing child may withdraw to himself and make no effort to adjust to others or to social situations. He may even blame others for his mistakes or unhappiness, and become a complaining, inefficient person. The teacher should look out for such signs and give the hard-of-hearing child a seat near herself, and make certain that the defect is taken care of in other ways. The totally deaf child belongs, of course, in a school for the deaf. Frequently special classes can be arranged for the hard-of-hearing. Serious cases, such as running ear, should be referred to a capable physician as soon as they are discovered. Because of the importance of language in education, mental development, and social life, defective hearing and deafness are often considered more serious than defective vision. Language ability is always retarded in the deaf child, and the hard-of-hearing has serious difficulties in dealing with language forms.

Discrimination Tests

Visual Discrimination

There are many ways of testing visual discrimination, or the ability to discriminate between visual stimuli of different degrees of intensity. One is to present a series of pairs of standardized gray stripes, asking the subject to report which gray of the separate pairs is of the lighter or darker shade. Another is to present a series of pairs of standardized lights, asking the subject to report which of the two is lighter or darker. Still another is to present a series of standardized pairs of colors,

asking the subject to report the lighter or darker shade. The amount of discrimination is determined by the amount of difference between the stimuli that the subject can distinguish as being different, the amount of difference being previously determined. (9)

Auditory Discrimination

The most common test of auditory discrimination is that of pitch discrimination, which consists in asking the subject to report whether two tones presented in immediate succession are the same or different, or to tell which is the higher or lower in pitch. The tones may be produced by tuning forks, ready-made phonograph records, or a musical instrument of any kind. The method of testing usually begins with tones widely different in pitch and proceeds by narrowing the difference until the subject reports that the tones are the same or shows that he recognizes the difference with difficulty. (9)

Tactual, Pressure, and Kinaesthetic Discriminations

These types of discrimination are measured by a variety of tests. One test that measures elements of all three types is that of weight discrimination. In this the subject is asked to compare a series of weights, ranging from 80 to 120 grams, by lifting each between the thumb and fingers. He may tell which of two weights is heavier or lighter or arrange them in order. In this way, the difference limen is represented by the smallest difference between any two weights that the subject can detect and report correctly in 50 per cent of the trials. The weights are alike, of course, in color, size, and shape.

A test for tactual or pressure discrimination is known as the *esthesiometer test.* This test consists in finding the smallest distance between two points applied simultaneously to the skin, by which a subject can experience two tactual or pressure sensations or impressions. The test is made by an esthesiometer, an instrument consisting of a handle and two adjustable points having the distance between them accurately gauged. When the points are applied to the skin close together, a single impression results; but if the points are applied at gradually increased distances, a distance can be found which is just sufficient to yield a perception of two points. This difference is known vari-

ously as "two-point threshold," "limen for duality," "esthesiometric index," etc. It may be found for different parts of the body and used as a measure of "general sensibility" under varying conditions. This test may have value for measuring special capacities which are of interest to teachers of the blind. (9)

PHYSICAL CONDITION AND MOTOR TESTS

Classifications

Two additional types of tests, in which educational psychologists and workers in the field of physical education have been considerably interested, are: (a) certain physical condition tests, and (b) tests of muscular strength, endurance, speed, and accuracy and precision. While reference has already been made to several of the specific tests included in these two types, it will be profitable to study them in some detail. We shall devote a separate topic, therefore, to each of the following: (a) tests of physical condition; (b) strength tests; (c) endurance tests; (d) speed of contraction tests; and (e) accuracy and precision tests. The last three types may be thought of as a group usually referred to as *motor tests* or *tests of specific motor capacities.*

Physical Condition Tests

Physical condition tests include a number of methods and devices employed to determine the extent to which vital functions correspond with or vary from the normal. Many such tests belong exclusively to medical practice, but there are certain ones that are frequently made by psychologists and specialists in physical education. Those most frequently employed are: (a) vital capacity, and (b) pulse rate and blood pressure, to which attention will be given here.

Vital Capacity

Vital capacity, also termed breathing or differential capacity, is measured in two ways: (a) by means of a spirometer and (b) by means of a U-tube. The spirometer test measures the volume of air that one can expire after taking a maximal inspiration. The U-tube test measures the amount of time a

subject can sustain a column of mercury 40 mm. high in a U-tube by the force of air breathed into one side of the tube. Both tests are believed to furnish important indices of general physical condition and capacity of individuals.

Spirometer measures have been taken and compared with various other measures. They show a positive correlation with age, posture, amount of daily exercise, school grades, and various measures of mental ability. That is, persons who are young, who exhibit poor posture, who take little physical exercise, and who make low grades or reveal low mental ability in other ways, have been found to have relatively low vital capacity, in comparison, at least, with those who have high ratings on these traits. The ratio of vital capacity to weight is known as *vital index.* This measure is thought to be an index to the balance between bodily size and the rate of oxidation of the blood. A high vital index is thought to be essential to physical endurance and to resistance to diseases.

The U-tube, or manometer test, as it is sometimes called, is frequently given in connection with measures in pulse rate and blood pressure, the latter measures being taken before, during, and after the former. Low ratings on each of the tests are usually considered indices of physical unfitness. (2)

Pulse Rate and Blood Pressure

Pulse rate and blood pressure have been used rather extensively in physical education as tests of physical condition. The value of the tests grows out of the close relations these factors sustain to muscular strength and performance. It has been shown, for instance, that abnormal changes in pulse rate and blood pressure resulting from certain types of exercise are fairly accurate indications of improper balance of delicate interactions of the nervous system, heart, and blood vessels. This imbalance, in turn, may be brought on by disturbances in digestion, poisons in the blood, abnormal secretions of the glands, fatigue resulting from hard muscular labor, and from extreme mental exertion, etc. Thus, a test of this type will indicate any of these conditions as well as extreme muscular weakness. On the basis of norms that have been worked out, it is possible to grade each individual on his fitness to engage in tasks requiring physical or mental exertion.

The tests that employ these measures vary according to the type of exercise required of the subjects tested. One set of norms has been worked out showing normal and abnormal changes in pulse rate and blood pressure occasioned by rising from a reclining to an erect position. Another set shows the changes occasioned by this movement and by a prescribed type of exercise. Another test requires pupils to take their own pulse rates while standing at ease and at various intervals after running in place at the rate of three steps per second, lifting the feet six inches from the floor, for a period of several minutes. The children are asked to take their pulse rates at intervals of one-half, one, two, and three minutes after the exercise. The score or grade on the test is the time required to recover normal rate. Grade A indicates that normal pulse rate is recovered in one-half a minute, grade B in one minute, grade C in two minutes, grade D in three minutes, grade E when the rate is slower after running. If the pulse is irregular, one grade lower than the rate indicates is given. Children making a grade of E are advised to consult a physician. The object of such tests is to enable teachers of physical education to select those pupils who need a physical examination by a physician and those who may be permitted or requested to go ahead with the physical education program. (2)

Strength Tests

Frequently it is desirable to know the muscular strength of pupils and the variations of this trait under different conditions. It is also desirable to know how strength varies with age, sex, race, anthropometric measures, athletic ability, intelligence, abnormalities of various types, and many other like traits. In order to supply this information, various methods of measuring strength have been devised. These include the following: (a) tests of grip, (b) strength of back, and (c) strength of legs. Each of these tests and some of its uses will be described.

Grip Test

The grip test is made on a *squeeze dynamometer*. This instrument consists of two oval bars held apart by a spring, with a pointer and dial attached. The instrument is held in the hand

and squeezed, and the pressure exerted on the two bars is registered on the dial by the pointer in pounds or kilograms. When taking the test, each subject is instructed to follow a standard procedure. The score on the test is the best record of three trials.

The grip test has been used to study growth in muscular strength. Growth curves show a gradual increase in strength from six to eighteen years of age, with some irregularities during the period of adolescence. The test also reveals wide sex differences, girls being weaker than boys at all ages, particularly during adolescence. The amount of grip varies rather consistently with height, the tallest children showing the greatest amount of strength. Negro children on the average are stronger than white children. The grip test is by no means an index to intelligence, but there is some evidence which shows that bright pupils of the same race are stronger than dull ones. This is particularly the case with feebleminded children. That is, high-grade feebleminded children surpass low-grade feebleminded children in grip. High-grade athletes usually exhibit a stronger grip than those who do not possess athletic ability. These are only a few comparisons that have been made to show the relation of grip to other measurable traits. (2, 9)

Strength of Back and Legs

The strength of back and of legs tests are used in connection with tests of grip as an index of general bodily strength. The instrument employed is a back and leg dynamometer, which is made on the same order as the squeeze dynamometer, except that it is attached to a foot piece and has a handle that can be gripped with both hands. The subject stands on the foot piece, holds the handle, and gives a hard lift, and the amounts of strength exerted are registered on a dial. In order to test the back, the subject pulls upward without bending the knees. To test the legs, the subject bends the legs, takes a deep breath, and gives a hard lift, chiefly with the legs.

These tests are used for essentially the same purposes as the test of grip. As suggested above, they are used as indices of general bodily strength, and their measures can be used for making any studies of comparison that the investigator may desire. (2, 9)

Endurance Tests

A number of tests have been designed to measure muscular endurance, or the capacity of the individual to exert muscular strength during a period of time. These tests include (a) endurance of grip, and (b) the ergograph test.

Endurance of Grip

This test has several variations, two of which may be mentioned. One is that of taking records of grip at every fourth beat of a metronome, set at sixty beats per minute, until as many readings are made as are necessary for the problem under investigation. The other involves taking records from the dynamometer during a continuous squeeze, noting the amount of grip at every fourth beat of the metronome.

The Ergograph Test

The ergograph is an instrument designed to measure changes in the amount of muscular contraction in a single member of the body, usually the middle finger, while other muscles are rendered immobile. The instrument consists of an arm support, to which the arm and hand are strapped so as to leave the middle finger free, and a system of pulleys over which extends a cable from the finger to a weight. The subject is asked to lift the weight by contracting the finger and pulling the cable to which it is attached. Attached to the cable is a pointer that operates in contact with a revolving drum on which is placed smoked paper. As the subject moves the weight up and down, the distance it is moved each time is recorded on the smoked drum. The test consists in asking the subject to raise the weight and let it back for a given period of time and at a given rate. The weight, time interval, rate of lifting, etc., can all be varied according to the needs of the problem.

The object of this test, of course, is to test the endurance of the muscle, the amount of work it can do, its resistance to fatigue effects, the relation of endurance to mental traits, and to secure a particular measure of endurance that may be needed in solving a given problem. The test has been used in determining the effects of many factors on endurance, such as exercise, rest, food, increased atmospheric pressure, doses of alcohol, humidity,

tobacco, etc. One interesting discovery, among many others, is that pupils of high class standing show greater muscular endurance than those of low class standing. Another is that endurance varies during the course of a day, children showing a greater amount during late morning hours than in the early morning and afternoon. (2)

Tests of Speed of Contraction

Tapping

A tapping test, mentioned earlier in the text, is used to measure the rate or speed of muscular contraction. The subject is asked to tap as rapidly as possible on a tapping board or telegraph key for a period of thirty seconds or more. The number of taps is recorded on a counter by means of electrical appliances or on a smoked paper drum. In either case, a record of each contraction of the muscles of the arm is secured, the smoked drum arrangement giving the more accurate records.

The test has been used as an index to general motor capacity, perhaps more than any other test, and to measure the influence of such factors as fatigue, handedness, sex, age, practice, intelligence, epilepsy, insanity, and many others. It is also used to indicate growth and development of the traits and differences among individuals. Norms for tapping at various ages under prescribed conditions have been worked out.

Accuracy and Precision Tests

General Description

Various tests have been devised for measuring the accuracy and precision with which a subject can control the muscles of the arm, hand, etc. One test is known as the *aiming test*, which requires the subject to strike with a pencil crosses irregularly arranged on a sheet of paper. A *tracing test* requires the subject to move a stylus down a narrow groove without touching the sides. A *steadiness test* requires the subject to insert a stylus into holes of different sizes without touching the sides. Each test is designed to test a different type of simple voluntary movement.

Uses

The uses of these tests have not been very extensive. They are now used primarily for the study of individual and sex differences and for special cases, such as for testing those who are suffering from St. Vitus dance. (9)

MOTOR ABILITY TESTS

Meaning and Types

Meaning

Motor ability, as previously explained, refers to the ability of individuals to engage in gross physical activity. *Motor ability tests*, therefore, include any particular method by which this ability is measured or evaluated. Motor ability is distinguished from the specific motor capacities described above in that it may include several or all of these. That is, motor ability is not the ability to perform a single function; it is the ability to exercise a variety of functions in the performance of a given activity. Motor ability testing, therefore, is concerned with devising and applying methods of determining the extent to which individuals possess the ability to engage in gross or complex forms of physical activity.

Types of Motor Ability Tests

The tests that are most frequently employed in the field of motor testing are: (a) certain physical efficiency or diagnostic tests; (b) tests of native motor ability; and (c) measures of athletic skill or achievement. Let us notice the nature and uses of each of these types.

Tests of Physical Efficiency

Tests of physical efficiency are of several different types; (a) physical examinations, (b) special tests of athletic fitness, and (c) indices of physical make-up. Each will be described briefly.

Physical Examination

In the best school systems, pupils are usually given a fairly thorough physical examination at the beginning of school.

This examination is usually conducted by a physician or a school nurse or both. Its object is to reveal the general health condition of pupils and any special defects that they may possess. The examination usually includes tests of vision and audition, heart and lung action, nutritional status, and general bodily health. By means of this examination, especially from the records of heart and lung action, teachers of physical education can isolate those pupils who are unfit to engage in the general program of the department of physical training. These examinations may also reveal special deficiencies that can be overcome by corrective exercises.

Athletic Diagnostic Tests

While a physical examination may reveal the general physical fitness of pupils, it will not reveal their various abilities to engage in specific types of physical activity. Consequently, workers in physical education have devised many special tests of their own. An effort has been made, at least, to determine the elements of athletic fitness and to devise tests that will measure the extent of these elements in particular pupils. One conception of athletic fitness is that it consists of the following elements: arm and shoulder-girdle strength and co-ordination; hand, foot, and arm-eye co-ordination; body co-ordination and control; leg speed; and the like. None of these elements can be determined by the specific tests described above. Thus special tests to measure each have been devised. The tests are such as the following: dip on parallels; baseball and basketball throw for distance and accuracy; football punt for distance; standing broad jump; quarter mile run; potato race; diving distance; and dodging. A pupil who shows considerable weakness on any single test or combination of tests is assigned to a game or sport that will help him develop strength. The weakness is revealed, of course, when the pupil's score is compared with a table of norms or with a previously derived scale. (2)

Indices of Physical Efficiency

In an effort to discover simple ways of determining physical efficiency, efforts have been made to combine various anthropometric measures and scores on motor tests so as to yield coeffi-

cients or indices of efficiency. Those most frequently employed for this purpose are indicated below.

(a) Coefficient of vital efficiency $= \dfrac{\text{girth of upper arm} \times 100}{\text{girth of chest in expiration}}$.

This coefficient is a kind of indication of one's ability to engage in vigorous physical activity. Persons of low vital efficiency, for instance, are usually unable to engage in vigorous athletic performances without suffering unduly from the effects of fatigue.

(b) Physical efficiency of a man $= \dfrac{\text{weight} \times \text{height jumped}}{\text{height}}$.

The height jumped is determined by taking the highest point at which the subject can touch a paper disk above the head by jumping into the air. The coefficient is a rough indication of the physical efficiency of a man because it combines tests of bodily size with strength and co-ordination of movement.

(c) Index of build $= \dfrac{\text{weight}}{\text{height}}$.

(d) Type of stature index $= \dfrac{100 \times \text{sitting height}}{\text{weight}}$.

These indices help to reveal the general character of the build of an individual. The trait is only slightly related to efficiency.

(e) Vital index $= \dfrac{\text{vital capacity}}{\text{weight}}$ or $\dfrac{\text{vital capacity}}{\text{height}}$.

This index is related to one's ability to resist fatigue or to engage in vigorous physical activity.

(f) Physical fitness index $= \dfrac{\text{achieved strength}}{\text{normal strength for age and weight}}$.

(g) Physical index $= \dfrac{\text{sum of jumps in 15 seconds}}{\text{age} \times \text{height}}$.

In order to secure the sum of the jumps in (g), the subject is asked to jump as high and as many times as he can in fifteen seconds, staying within a circle two feet in diameter. An apparatus records the height of each jump, and the sum is derived from the record.

On the whole, such indices are useful only in selecting the worst cases of physical inefficiency. They are not useful as determiners of physical fitness for particular stunts or sports. When they are considered in connection with various anthropometric, sensory, and motor tests, however, they help to complete the picture of physical build, efficiency, and ability. (2)

Tests of Motor Ability

Description

As indicated above, and in an earlier chapter, general motor ability is measured by asking the individual to perform a series of activities involving various degrees of agility, co-ordination, quickness of movement, balancing, muscular strength, etc. The activities may be arranged in the order of difficulty so as to form a scale that will select individuals possessing different amounts of the total trait. At least, one such scale has been devised and standardized on children and college students of different ages. The scale is a series of twenty tests, such as the following: (a) walk ten steps in a straight line with the eyes closed, placing the heel of one foot against the toe of the other; (b) jump into the air and knock the heels together twice (or three times) before striking the ground; and (c) jump over the left arm while holding the right foot by the toe with the left hand. The tester gives the directions for and demonstrates each test, and observes whether or not the subjects can perform. A subject's score is the number of tests he can do successfully.

Values

It is believed that a pupil's score on a test of this kind is indicative not only of his ability to perform the particular tasks but also of his ability to engage in any type of performance involving the same or similar functions. Thus, motor ability tests are used in predicting probable success or failure in any type of general physical activity. They also help the teacher to discover and select pupils for various classes in physical education and to discover special abilities and defects. (3)

Motor Achievement Tests

Description

Motor achievement tests include a large variety of specific tests and batteries or combinations of tests designed to determine the degree of accomplishment or attainment acquired by pupils in athletic performances at different periods of training. The tests most frequently employed are the following: (a) standing broad jump; (b) baseball and basketball throw for distance and accuracy; (c) 40-, 50-, 75-, and 100-yard dash; (d) chinning; (e) swimming; (f) potato race; (g) jumping and reaching height; (g) hop, step, and jump distance; (h) football punt for distance; (i) horizontal bar feats; and various other functions.

Uses of Scores

Since each of the foregoing tests measures an ability that increases with age and with training and practice, it has been possible to establish norms of achievement for various ages. The norms may be used therefore to evaluate individual progress, rate individuals, determine passing and failing in physical training courses, estimate teaching efficiency, make awards, and the like.

In addition to the use of norms of such tests, scores are frequently based on records made in competitive field events. This type of norm is used as a kind of ultimate standard of performance for the best pupils. Records are kept of all field and track events so as to build up a set of norms by which individual performances may be estimated. (2)

Status of Motor Ability Testing

Motor ability testing is relatively new in the field of measurement. Consequently, much of the program is still in the experimental stage. Workers in the field of physical education, in particular, are very active in the search for better tests. Many studies are under way regarding the relations of numerous misuses to each other, and also concerning the values of particular batteries of tests. What is needed most, it seems, is a battery of relatively simple tests which a teacher can use as a basis for classifying pupils into homogeneous groups, and

which will yield information regarding the types of corrective exercises best suited to individual pupils. (10)

EXERCISES

1. Explain the following terms: test, scale, sampling, and variation. Give examples of each.
2. Indicate the values of norms in interpreting individual and group traits and abilities.
3. Which of the anthropometric measurements is of most and which of least value to teachers of literary subjects? Indicate the values of those you select.
4. Show why there is less interest in head measurements and indices at the present time than there was thirty or forty years ago.
5. Should teachers attempt to measure sensory functions? If so, what tests should they employ, and what uses should they make of the results?
6. Explain the term *psycho-physics* and indicate the types of measurements belonging to this field of study.
7. What are the best methods for determining the following: (1) general muscular strength, (2) physical endurance, (3) general physical fitness, (4) fitness to engage in violent exercise, and (5) physical efficiency?
8. Would a measure of physical efficiency yield a reliable index of general motor ability? Discuss.
9. Make a column list of the specific tests described in the chapter, and to the right of each indicate its specific values or uses.
10. Which of all the tests described in this chapter are of greatest value to elementary teachers? To physical education teachers?

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CHAPTER XVIII

THE MEASUREMENT OF SPECIFIC MENTAL FUNCTIONS AND ABILITIES

INTRODUCTION

Purpose of the Chapter

The measurements described in this chapter have to do with the evaluation of specific mental functions and abilities. These traits include those described earlier as affective states and complex mental processes. An effort will be made to show how each of the several functions is tested and some of the uses and values of the data secured. This division of the field of measurement comes under the general heading of *mental measurement*, which has for its general purpose the evaluation of both specific and general mental functions and abilities. In this chapter, attention will be given to devices and procedures employed in the evaluation of specific functions. A discussion of the measurement of general ability will be presented in the next chapter.

Classification

There are many types and uses of the tests and procedures which have been described above. Because of this great variety, there are also many ways in which these instruments may be classified and described. For the purpose of the present treatment, however, they will be divided into two general groups: (a) tests and measures of primary affective states, and (b) tests and measures of several of the mental processes. The first type will concentrate attention on the purposes, kinds, and uses of feelings, emotions, and tendencies; the second will deal with the varieties and uses of such mental processes as attention, distraction, perception, memory, and association. The discussion that follows will indicate, describe, and illustrate such specific procedures as are involved in evaluating the types of traits suggested.

TESTS OF PRIMARY AFFECTIVE STATES

General Purpose and Types

Purpose

Since feelings, emotions, tendencies, and other affective states are non-intellectual in character, they are measured largely for the purpose of determining their nature and the extent to which they arise in connection with different situations. Efforts are also made to determine the extent of differences among them in different individuals.

Types

The tests employed in measuring affective states include the following types: (a) tests of feelings; (b) tests of emotions; and (c) tests of tendencies. Each type may now be described and illustrated.

Tests of Feelings

The nature and amount of feeling being experienced in connection with a given stimulus or situation may be determined by either of two general procedures: (a) by introspection or personal estimate, and (b) by laboratory techniques designed to reveal the degree of bodily changes occurring as causes or effects of particular feeling states. The introspective procedure is called the *method of impression*, while the laboratory techniques are referred to as the *method of expression*. A brief discussion and a few illustrations will indicate the nature and uses of the two methods.

The Method of Impression

Suppose the tester is interested in determining the nature of feeling aroused by different stimuli, or of determining whether different individuals experience the same type of feeling when a given stimulus is presented. The usual procedure followed is somewhat as follows: (a) Select a given group of stimuli, such as pictures, tones, colors, etc. (b) Present them singly to different subjects, asking each subject to make a record of the type of feeling aroused or to estimate the degree of

pleasantness or unpleasantness experienced. In presenting stimuli and securing responses, a variety of methods have been followed.

METHOD OF CLASSIFICATION. Here, the subject is asked to regard each stimulus and to judge whether it is pleasant, unpleasant, or neutral. This method is employed when it is desirable to determine the kinds of objects, object qualities, or events that arouse the different types of feelings and also to find out which types of stimuli have no affective value.

ORDER OF MERIT. The *order of merit test* requires subjects to arrange a series of stimuli in the order of preference, like or dislike, or according to the degree of pleasantness or unpleasantness aroused by each. Usually not more than ten stimuli are presented, though many more may be presented, if it is desirable. This type of test is useful in selecting objects of the highest or lowest degree of preference, and in comparing the affective value of one object with that of another. It is also useful in the study of individual differences in regard to affective reactions to particular situations.

METHOD OF PAIRED COMPARISON. This method involves presenting stimuli in pairs and asking the subjects to judge which of a pair is more pleasant or unpleasant. When it is necessary to present the members of a pair in sequence, as in comparing tones, both sequences should be followed. When a series of pairs is presented, it is helpful to present them in different sequences. In any case, the accuracy of judgment is increased by repetition of the presentations. After such comparisons are obtained from a large number of subjects, the various stimuli can be arranged on a scale from the most to the least pleasant, by using the percentage of each type of judgment to represent separate points on the scale.

METHOD OF RATING. Another method of measuring feelings is the assignment of scale values to particular states. This is done by reporting whether a stimulus is "very pleasant," "mildly pleasant," "faintly pleasant," etc., or by assigning a number value to the degree of pleasantness or unpleasantness. Either method involves the rating of the experience in terms of a personal estimate.

GENERAL USES. Tests of feelings are used for a variety of purposes, such as the following: (a) to discover color or color

combinations that are most pleasing; (b) to reveal tones or combinations that have the lowest or highest affective values; and (c) to establish preferable sizes and forms of pictures, designs, and diagrams. They are used also to discover the nature and characteristics of feeling states. (1)

The Method of Expression

The *method of expression* comprises any procedure employed in the study and measurement of bodily changes which are regarded as accompaniments or "expressions" of feeling states. It is known, for instance, that such functions as breathing and heartbeat undergo changes during states of pleasantness and unpleasantness. Consequently, efforts are made frequently to determine the degree of feeling by measuring the degree of bodily change. This type of measurement involves the use of special instruments. That for recording breathing rate consists of a tambour attached by straps to the chest and articulated with a second tambour which operates a stylus in contact with a smoked drum. The assembly of instruments makes it possible to secure a record on the drum of the normal breathing rate and of any changes that occur as a result of a given stimulus. A similar mechanism is employed in recording the rate of heartbeat.

Laboratory studies of feelings are used to determine individual variations, the influence of feelings on other types of activity, and the effects of particular types of stimuli on the individual. They are not used very often as measures on school pupils, but rather as techniques for the investigation of research problems. (1)

Tests of Emotions

Attempts to measure emotions have resulted in the development of procedures that are similar to those employed in the measurement of feelings. That is, the measuring devices are designed to study both the subjective and objective components. The measurements most commonly employed include the following types: (a) questionnaire, (b) rating scale, (c) direct observations, (d) various laboratory procedures and techniques, and (e) standardized tests.

Questionnaire

The questionnaire on emotion is a carefully constructed list of questions designed to secure answers which will reveal the emotional nature of the individual. In one such instrument, there are seventy questions dealing with fears, worries, unsocial moods, and the like. Such questions as the following are typical:

(a) Are you bothered much by blushing?
(b) Is it easy to make you laugh?
(c) Do you like to play alone or with others?

One who answers all the questions reveals, of course, the number of situations in which he usually becomes emotional, and the particular questions reveal the nature of these situations. A score on the test is indicative of an individual's *general emotionality.* Nevertheless, because of the error to which any kind of questionnaire is subject, this type of emotional test is most generally used as a preparatory measure for further measurement or research. On the whole, however, it gives a fairly accurate index of a person's emotionality.

Rating Scales

This type of measurement deals more with specific responses than general traits, though some rating scales are intended for the judgment of general emotionality. One form of rating scale is designed to reveal the frequency of occurrence of various types of emotional behavior in individuals. The scale is to be used by observers of the individuals measured rather than by the individuals themselves. Following is an example of the type of scale employed: "Talks in a shrill voice; never___ rarely___sometimes___usually___often___constantly___." In using the scale, the observer recalls his experience in regard to the individual and places a check mark beside the word that most accurately describes the trait under consideration. The entire scale is made up, of course, of a rather large number and variety of items. When carefully checked by observers who are well acquainted with the subjects, the rating scale reveals a large amount of useful information about them. Nevertheless, this type of rating scale, like the questionnaire, is subject to

numerous inaccuracies. It should be used, in the main only by persons familiar with such procedures.

Another kind of rating scale involves assigning a numerical value to each trait observed. Crying may be measured, for example, by assigning values as follows:

Child does not use crying as means of expressing his emotions....1
Crying is brief.......................................2
Crying varies normally with the nature and intensity of the stimulus...3
Cries only when exceptionally hurt or disappointed.............4
Crying is a dominant way of expressing emotion...............5
Child is exceptionally prone to cry.........................6
Child is a "cry baby"—cries on slight provocation.............7

When suitable ratings of this type are used for a variety of traits, such scales yield fairly reliable indices of the emotional nature of children. The best results are obtained, of course, by observers who are well acquainted with the subjects and who have had special training in the use of rating scales and in observing emotional behavior. (5)

Direct Observation

The measurement of emotions by direct observation consists in observing and recording the behavior of children in emotional situations. Usually the child is confronted with a difficult or impossible task, such as that of opening a box containing a toy. If the child gives up the task and cries, he is judged as very emotional; if he works at the task persistently and does not cry, he is judged as relatively unemotional; etc. It is possible to assign a definite score to each child by taking the average time that he works at a variety of tasks before becoming emotional. This method is employed in studying and measuring the emotionality of very young children.

Laboratory Techniques

Efforts are made to measure emotional reactions by various laboratory techniques. These techniques are concerned mainly with determining the extent to which visceral and somatic changes are produced by emotional stimuli. The changes most frequently measured are those that take place in pulse rate, heartbeat, digestion, and respiration. In order to record these

changes various instruments are operated in connection with an indicator in contact with a smoked drum. By measuring the up and down movements, before and after an emotional stimulus, the degree of change effected by the stimulus can be ascertained. This type of recording device is frequently employed in measuring and studying emotional changes to known stimuli.

Perhaps the most accurate method of determining the intensities of emotions is by means of the *psycho-galvanometer.* This instrument indicates changes in the electrical conductivity of the skin. It consists mainly of an external source of current, and a pair of electrodes attached to the subject and to the opposite poles of a delicate galvanometer, so that electrical impulses in the skin are indicated on a dial. The examiner observes the position of the indicator before and after the stimulus. Since such records show variations in the conductivity of the skin corresponding in magnitude to changes in the intensity of the stimuli, the galvanometer yields fairly reliable information regarding the intensity of the emotional states experienced. (1, 3)

Standardized Tests

Since emotions enter into other complex forms of behavior and through conditioning become elaborated to form habitual patterns, such as moods and temperaments, efforts have been made to construct standardized tests which will reveal the presence of such patterns in different individuals. One test, devised to determine general emotionality, is made up of lists of words among which are many calculated to suggest emotional situations or to serve as emotional stimuli. The subjects are asked to read through the list and to draw a line through each word that they like or dislike. The score on the test is the number of words marked. These words were previously selected as words which usually have emotional value. The number of words marked reveals the general emotionality of each subject. Nevertheless, because of the difficulties involved in making the selection, the validity of such tests is somewhat doubtful.

Other standardized tests of this general type are designed to reveal the extremes of emotionality. These are usually called

psycho-neurotic inventories, and they consist of graded statements and questions regarding emotional experiences. A person who reveals a strong tendency to mark the statements and questions so as to indicate extreme likes and dislikes in numerous particular instances is exhibiting one of the characteristics of a *psycho-neurotic*. Such tests have proved of considerable value in isolating cases in need of special attention and treatment. They also help to discover the causes of mal-adjustment in many cases.

A third type of standardized test dealing with emotional states is designed to reveal the extent to which affective states have occasioned the development of systems of sentiments, emotive attitudes, and beliefs in individuals. These systems of reactions are mixtures of intellectual attainments and emotional states which have become attached to or integrated with them. Since anyone is inclined to acquire patterns of thought and action that are motivated chiefly by affective states, these systems tend to dominate one's total behavior. When such domination is effected in an individual, so that his behavior is chiefly motivated by affective elements, it seems possible to classify him as an *extrovert* or an *introvert*. Several tests designed to measure the extent of extroversion and introversion in individuals have been constructed. One such test is a series of questions to be answered "yes" or "no," of which the following are examples.

(1) Do you shift jobs during the day?
(2) Are you inclined to forget the feelings of others?
(3) Do you keep yourself in the background at social affairs?
(4) In social conversations, are you merely a listener?
(5) Do you ever try not to lend things?
(6) When praised, do you work much better?
(7) Do you usually work out things without asking help?
(8) Has the opposite sex proved uninteresting to you?
(9) Do you prefer to work alone or with others?
(10) Are you cautious in making new friends?

In marking such questions in certain ways, a person reveals the extent to which he tends to project himself outward toward the environmental circumstances of life so as to overcome obstructions and difficulties, or the extent to which he recoils from such circumstances and finds modes of adjustment within

himself. The first type of person is the extrovert; the second, is the introvert.

Another test or inventory of this type consists of 48 questions with graded answers, as follows:

1. How steadily have you worked at the ordinary tasks of the day? (1) continuously until completed; (2) steadily only at enjoyed ones; (3) shifted only with mood; (4) shifted from one to the other; (5) spurts of work.
2. In social conversation how have you been? (1) talkative; (2) an easy talker; (3) talked when necessary; (4) preferred listening; (5) refrained from talking.
3. How are your beliefs in politics, religion, social change, etc.? (1) urge liberal changes; (2) think many changes needed; (3) think changes needed in some lines; (4) give them little thought; (5) hold traditional views.
4. Have you unburdened your troubles and worries? (1) very freely; (2) inclined to be confidential; (3) tell some troubles; (4) rarely unburden them; (5) keep them all to yourself.
5. What have you done when things went wrong? (1) felt sorrow and pity for self; (2) sorrowful but not entirely discouraged; (3) tried to rectify them; (4) indifferent to many; (5) gave them little thought.

These and the other test items have been selected to reveal tendencies toward extroversion and introversion. Some questions deal with extroversion; others with introversion. The graded answers, when compared with a table of norms, reveal whether the individual is an extrovert, or introvert, and the extent to which he possesses the trait.

The true range of usefulness of such tests has not been fully verified. Up to the present time, they have been used to study sex differences and to reveal causes of mal-adjustments in occupations and various social situations. They are thought to be useful instruments for revealing personality types, though personality is a broader concept than extroversion or introversion. They seem to have their chief usefulness in revealing the general emotional make-up of the individual. (8)

Tests of Tendencies

Among the most difficult human traits to measure or evaluate in any accurate way are the traits we have previously called tendencies or urges, cravings, drives, and motives. These are difficult to measure for the reason that they operate in

such a large variety of ways in different individuals. Yet, the very fact that they exist has occasioned the development of various procedures for determining their strength or their effects on many types of behavior. The measurements may be classified in terms of the different types of tendencies measured. We find the various types that are listed and described below.

Tests of Physiological Tendencies

Though physiological tendencies appear to be the most fundamental in human nature and conduct, very few efforts have been made to measure them in human beings. What is known about them, as far as measurement is concerned, has been inferred chiefly from experiments on animals. In this field a number of efforts have been made to determine the relative strength of various tendencies and to study their effects on various forms of behavior, particularly on learning. The strength of tendencies has been measured mainly by the so-called *method of obstruction.* In this an animal, such as a white rat, is separated from an object by an obstruction, an electric shock. The strength of the tendency is inferred from the strength of the obstruction which just begins to inhibit his crossing, or by the amount of behavior engaged in by the animal to reach the object. In one testing situation, a hungry animal is placed in one compartment and food in another, and an electric pad or other shocking device is placed between the two compartments. The strength of the hunger is inferred from the amount of shock that the animal will endure in order to get to the food. Efforts have been made not only to measure the strength of hunger, but also the strength of thirst, sex desire, and the maternal drive or desire to get to the young.

When the effects of tendencies on learning are studied, the animal is confronted with a learning situation and motivated by hunger or other drives to make efforts to reach food or other satisfiers. Here the strength of the drive is inferred by finding the difference between the rates of learning with and without the motive. Many experiments of this kind have been performed on animals, but very few have been performed on human beings in which fundamental drives were employed as motives. (1, 3)

Tests of Emotional Tendencies

Many of the tests of emotions described above serve the purpose of isolating and evaluating emotional tendencies. It is this type of drive that prompts individuals to form many of the complexes, moods, temperaments, and phobias described earlier in the text. The standardized tests that are intended to reveal psycho-neurotic traits and extroversion and introversion are likewise measures of emotional tendencies and their effects.

TESTS OF MENTAL PROCESSES

Meaning and Purpose

By *tests of mental processes* is meant an assortment of procedures and techniques designed to measure the relatively complex mental functions previously described as attention, perception, memory, etc. These, it may be recalled, comprise the basic processes involved in various types of learning. Efforts to measure them are intended to reveal their nature and the various factors that influence them, as well as the extent to which they vary in amount among different individuals. The number of procedures and techniques that have been employed for one person or another is too large to review in the present treatment, but a few of those most frequently reported in the experimental literature will be described and illustrated.

Tests of Attention

Attention, it will be recalled, is thought of as the process of focalizing consciousness upon a given stimulus for the purpose of sensing its qualities or of inspecting, studying, and thinking about it. In its most fundamental character, attention is a specific act of momentary duration. A series of acts may occur, however, in regard to a particular object, and such a series results in sustained attention. Typical tests of the power of attention in individuals include procedures for measuring the following aspects: (a) fluctuations, (b) scope and range, (c) determiners, (d) physiological accompaniments, and (e) effects of distraction. A few samples of each type of test will be described.

Fluctuations

In order to demonstrate and study the fluctuations of attention, several tests have been employed. These include the following:

(a) Dot Test. Have the subjects attempt to give attention to a dot for sixty seconds. During this period, let them make a mark to record each time they lose clear consciousness of the dot. Divide the number of marks into 60 to get the average number of seconds attention appears to be static.

(b) Book Test. Have a group of subjects observe the ambiguous figure called 'Mach's book' for a period of sixty seconds, and make a record of the times the figure appears to change from the front to the back of a book. Divide this number of marks into 60 to get the average number of seconds attention remains constant.

(c) Image Tests. Another way to study and demonstrate the fluctuations of attention is to have a group of subjects note the number of times the image of a familiar object, such as an ink bottle, appears to fade from consciousness in a period of sixty seconds.

In each of these tests, individuals will find that attention is a series of momentary acts sustained toward a given stimulus; that consciousness fluctuates or changes with a high degree of rapidity; that attention can be given to only one or a very few things at a time; and that individuals differ widely in their abilities to control the acts of attention. (1, 6, 7)

Scope of Attention

Tests of the scope of attention are designed to answer the question, "How many things can be attended to at once?" Most of the tests that have been evolved to answer this question involve short exposures of dots, letters, words, objects, pictures of objects, etc. The exposure times are controlled by a device known as the *tachistoscope,* of which there are many types. One type is a photographic shutter and projection lantern assembly. The test items are put on lantern slides and shown for brief periods of time, usually about $\frac{1}{5}$ of a second. The subject focuses attention on the spot where the object is to appear, and the experimenter causes the objects to appear

by tripping the shutter. The subject then writes down or describes what he sees. The largest number of objects seen and described or named is the measure of his "span of attention."

By using separate items, and items arranged according to some definite pattern, such a test can be employed to study the factors that influence attention, such as familiarity, organization, size, etc. It has been found, for instance, that only about five separate letters can be apprehended when they are presented singly but a greater number when they appear in words or sentences. (1, 7)

Determiners of Attention

A variety of tests have been used to show the effects of such factors as clearness, contrast, repetition, and vividness on attention. One way this is done is to exhibit lists of words containing one or more words possessing one or the other of these factors or qualities. In a list of twelve words, for example, one word appears in heavy type; in another list of twelve words, one or two appear in italics; in another list, one or two words are underscored; and in still another, a word or two is printed in capitals. When such lists are presented one at a time for a period of five to ten seconds, and the subjects are asked to observe the lists, and finally to write down all they can remember immediately after the exposure period, the word or words in heavy type, italicized, repeated, or written in capitals, are usually the only ones written down. The results of the test will show, at least, that there is a strong tendency for subjects to give attention to the words that differ from the others, unless there is some stronger determiner present in the other words. This fact indicates, of course, that a higher degree of attention is given to words or objects having distinct or striking qualities than is given to other words or objects possessing no such qualities. (1)

Distraction Tests

A relatively large number of tests has been used to show the effects of distracting stimuli on mental work requiring continuous attention. One example of this group may be described briefly.

Let a group of subjects read a selection of material in a quiet

room, and then determine the number of questions they can answer on the material. Second, present a selection of the same type of material and of equal difficulty; but just as they start reading, introduce a disturbing noise, such as the clanging of a gong or the sound of a buzzer, and determine the number of questions they can answer at the end of the reading. Finally, compare the number of questions answered correctly on the first selection with the number answered correctly on the second. The difference, of course, will reveal the effects of the distraction on the reading process.

General Results of Attention Tests

The foregoing are but a few samples of a great variety of tests of attention, which psychologists have used in studying the process. The results of such tests reveal the nature of attention in regard to various types of stimuli, and under various conditions; and they reveal many significant individual differences in the power to give attention in particular situations. So far, however, no one has been able to perfect a test that exhibits attention as a general power or ability existing in each individual in a constant amount. In other words, attention varies in the same individual according to the types of stimuli presented and according to numerous motives, goals, mental sets, etc.; so that it cannot be isolated as a special or general ability. This is one of the reasons why there is no standardized test of attention.

Tests of Perception

Tests of perception vary in kind according to the factor or specific ability it is desired to measure. In the various manuals of psychology, the following types may be found: (a) tests of the range or scope of perception; (b) tests of abilities to recognize varying types of stimuli or qualities, such as words, colors, objects, etc.; (c) tests of the quickness of perception; (d) tests of observation, such as the ability to observe details; (e) tests of the span of perception; (f) tests of abilities to localize sights, sounds, and touches; (g) various discrimination tests, as of differences between stimuli presented simultaneously; and many others. Attention may now be given to a few samples of several of these.

Scope of Perception Tests

One type of test that has been used to measure various abilities of individuals in regard to perception is concerned with the scope of perception. By scope is meant the number of stimuli of a given kind that subjects can recognize. The stimuli may be selected from any field desired, such as names, words, objects, pictures, mathematical symbols, and the like. The tester exhibits the items in a convenient manner, and asks the subjects to name or identify them. A word recognition test, for instance, consists in presenting a subject with a list of words and asking him to tell what each is. A color perception test requires the subject to point to and name a series of different colors. Frequently, subjects are asked to define a selected list of words, or to name a group of objects of a particular kind. The general purpose of such tests is to discover not only the scope of perception in children but also their lack of understanding of particular items. From the individual scores, the psychologist or the teacher may infer the pupil's readiness or lack of readiness to understand various types of subject matter; conclude what should or may be emphasized in teaching; and infer the range of differences among children. (1, 7)

Perceptual Reaction Time

The quickness of perception, as previously noticed in the discussion of perception, is determined by measuring the time elapsing between the appearance of a given stimulus and the subject's act of recognizing it. This lapse of time, usually designated as *reaction time*, is frequently so short that it has to be measured by means of a chronoscope. This is an instrument which can be started at the precise time a stimulus appears and stopped the moment the individual responds. Most chronoscopes register the time interval in one-thousandths of a second. By using this instrument, psychologists have measured the time required to respond to a large variety of stimuli discerned through each of the senses. Particular attention has been given to comparisons of the time required to react through the senses of sight, hearing, touch, warmth, cold, and pain. Numerous studies have also been made of the effects on reaction time of such special factors as stimulus intensity, size, color, pitch,

number of presentations, familiarity, and the like. Studies have also been made of the effects of the focus of attention, or the effects of directing attention to the stimulus, or upon the movements involved in making the response. Considerable attention has been given to reaction time to different types of words.

The tests just mentioned usually require a tester to administer them who has had considerable training in the use of laboratory apparatus. A much simpler test of the span and quickness of perception is known as the *cancellation test.* It consists in determining the rate at which subjects can cancel or mark out particular letters, or other items, appearing among others only slightly different. For instance, a subject might be asked to mark through all of the *e*'s, *a*'s, or *i*'s on this page of print, or in any other prose selection, or in a previously prepared list of letters. The score on such a test is the number of letters that the individual cancels in a given length of time. Reaction time is obtained by dividing the number of letters canceled by the number of seconds required to cancel them. (1, 7)

Observation Tests

Among the most interesting tests of perception are certain details in objects or pictures. One simple test is that of asking subjects to name missing parts in imperfect objects or pictures, such as the eyes in the picture of a lady, or the handle of an umbrella. The pictures are usually especially prepared for the purpose. The subject is instructed as follows: "There is something wrong with this picture. See if you can find what it is."

Another similar test involves exhibiting a picture of some degree of complexity for a specified length of time, and instructing the subject to observe it carefully. After the time has elapsed, the subject is asked to name or tell as many objects as he can and to answer a number of questions about the picture. (7)

Span of Perception Tests

The observation tests just described are similar to several tests designed to measure the span of perception. This, it will be recalled, is the number of items that an individual can recognize during a brief interval of time. One such test is known

as the "six-second exposure test," which is given somewhat as follows: Familiar objects are arranged on a table or tray, or in a box, where they can be covered and uncovered. The subject is instructed to observe the objects as soon as they are uncovered. The cover is then raised, while the subject observes, and then it is lowered after an interval of six seconds. The subject is then instructed to tell or write the names of all the objects that he saw. The number of objects represents the subject's span of perception.

More accurate tests of this ability involve the use of the tachistoscope. By means of this instrument, the time of exposure is accurately controlled, and it can be varied to suit the needs of many types of material. The span of perception test is not a measure of quickness but of the number of items that can be perceived in a given interval. It is very similar, of course, to the span of attention, except that longer time intervals are usually employed. (7)

Perception Tests in General

It would be useless to mention and describe the numerous tests of perception that have been devised and used in psychology laboratories. They, like tests of attention, are almost unlimited. The essential point here is that mentality is such a complex entity that it manifests an endless array of specific abilities, of which perception of many types is only one. Furthermore, work in this field has served as a background for devising tests of another type to be discussed later.

Conception Tests

A third type of tests in the field of mental measurement is one we may call *conception tests.* These have to do with the measurement of the products of the processes involved in conceptual learning; that is, the products of classification, abstraction, and generalization. The tests are similar to perception tests in that they are concerned with the scope, efficiency, and speed of reactions; but they differ from perception tests in that they measure a different type of response and employ a different type of test item. Whereas perception tests measure single reactions, such as specific responses to concrete stimuli, conception tests measure general reactions, or responses to symbolic

stimuli. In other words, perception tests measure ability to recognize things, while conception tests measure ability to understand things, particularly abstract words, questions, verbal problems, and the relations between the items in each. The number and variety of such tests make it impossible to discuss them in great detail, but attention will be given only to a few of the most representative types. These are (a) vocabulary tests; (b) tests of general information; (c) tests of relations; and (d) tests of number concepts. Some attention has already been given to these in the discussion of conceptual learning in a previous chapter.

Vocabulary Tests

Vocabulary tests are designed to measure the extent to which individuals understand words. This is done, as a rule, by determining the number of words that can be defined. A test that will reveal the number of words understood is a conception test, for the reason that language development and concept formation run parallel in the mental development of every individual. Language forms, it may be recalled, are the tools by which concept formation is effected, and the concept is the tool for abstract and logical thinking.

The problem of determining the actual number of words that an individual knows or understands is impossible of solution. In order to do this, the tester would have to ask the subject to define every word in a complete dictionary, and from the definitions select the words properly defined. Since this would be next to impossible, several techniques have been worked out whereby an approximation of word knowledge is made. The usual practice followed is that of selecting words from certain pages or columns in a dictionary. One test, for instance, includes 100 words selected by taking the last word in every sixth column of *Laird and Lee's Vest-Pocket Dictionary*, which contains a total of 18,000 words. It is assumed, of course, that this method of selection will yield a list of words which will represent the total word knowledge of the subject. The test is administered by giving a subject one word at a time and asking him to define it. Each word is presented in printed form and pronounced by the tester, whereupon, the subject offers his definition orally, and the tester scores the answer 0, 0.5, or 1, accord-

ing to the estimated value of the definition. The sum of the scores assigned the different definitions represents the individual's score on the 100-word test. The size of the individual's vocabulary is determined by taking this score as a per cent of 18,000, and finding the subject's total vocabulary.

A simple variation of the test just described consists in having the subject check the words rather than define them. The words are checked according to the subject's judgment of his knowledge of them. By using different marks, or numbers, for example, he checks those that he can define, the ones that he can explain, those that are roughly familiar, and those that are unknown. This type of test has an advantage over the one previously described in that it can be given to groups of individuals. It has a disadvantage, however, in that the score depends upon a subjective factor involved in the rating of the degree of knowledge the individual thinks he possesses.

Other vocabulary tests are constructed by selecting words most commonly used, such as those most frequently found in newspapers, school texts, or in pupils' themes and letters. A number of word lists for pupils of different ages and grades have been selected in this general manner; and various tests have been constructed by selecting words at random from such lists. In most tests, subjects are not asked to define particular words but to select the proper synonym or definition from several provided in the test. By selecting the proper answer from a number of incorrect ones, the subject shows that he understands the word in any given test item.

The results of vocabulary tests have been used for a variety of purposes. They have been used to estimate the size of vocabulary for pupils in different school grades. They have also been used as indices of language development. They have been studied in relation to such factors as sex, amount of reading, teachers' grades, class standing, etc., and they have been used to reveal the factors that influence the growth and development of vocabulary. The definitions offered by subjects have been used to determine the relative difficulty or degree of understanding of different types of words, such as abstract, concrete, and structural words. They have also been used to reveal the types and sources of error in children's understanding and thinking. The scores on a test may be considered indices of

conceptual development, or of language attainment and general intellectual status. (7)

General Information Tests

Another type of test that follows the same general plan and purpose of a vocabulary test is the *general information test.* This type of test consists of various procedures designed to determine the subjects' knowledge of facts or ideas drawn from a variety of fields. One test of this type stresses the knowledge of ideas obtained from general reading and observation; and another stresses information derived from informal learning in special fields, such as literature, golf, and aviation. The object of such tests is usually that of obtaining a score that will reveal the intellectual attainment of individuals when this attainment has come about apart from the influence of usual instruction. Such a score is regarded as a partial measure of intelligence, it being assumed that general information is as much a product of this factor as it is a product of learning activity or specialized training and instruction. This assumption is made for the reason that usually the more intelligent an individual the greater is his range of information.

Tests of Relations

Since conception is mainly a process of observing and synthesizing relations among stimuli, another method of measuring ability to conceive, or the extent to which conceptual development has taken place, is by means of *tests of relations.* There are many varieties of this type, each of which is designed to determine the extent tc which subjects can understand and deal with different relations. Most of these tests emphasize either object relations or relations among abstract ideas.

Tests of object relations usually contain test items involving concrete objects or pictures. When objects are used, the subjects may be asked to separate the objects of several types into classes. When pictures are used, the subjects are asked to mark the pictures belonging to particular classes or to indicate similarities and differences among the pictures. In one test, for instance, the subjects are asked to look at different groups of pictures and to draw a line under each that is named. The pictures are arranged in rows, three or more in a row, one of

which is usually called by some name and the others are unnamed objects, such as a key, a pear, or a cup. From other groups of pictures in this test, subjects are instructed to find a picture that will represent a given word; to find and mark all right and left hands and feet in a series of pictures of both right and left feet; to find a drawing in each of several rows of drawings, which is the same as the first drawing in each row; to find a picture that goes with the first in each row; etc. The task of the subject, or course, is that of observing the first picture and then of finding among the others one that is related to it in the prescribed way. The relation may be any one of a large number of relations, such as similarity, opposite, cause, effect, part, whole, genus, species, or any other it is desired to measure.

Other tests make use of verbal problems and relations. When this type of test is used, each test item may consist of a question or problem having a correct answer among several that are incorrect. The task of the subject is that of understanding the question as a whole, observing the relation that is prescribed, observing and conceiving the nature of the possible answers, noting the relation of each possible answer to the prescribed relation, and deciding upon the correct answer. Such test items as the following will illustrate those that are commonly used:

(a) Which of the five things below is most like *horse?* wagon, rat, run, ball, house.

(b) Which of the five words that follow means the opposite of *bright?* shining, brilliant, dull, black, sun.

(c) Draw a line under the word which means the same as *nearly.* always, frequently, rarely, never, almost.

(d) A is equal to B. B is equal to C. Therefore: B is larger than C, A is equal to C, A is equal to B plus C.

(e) Supply the missing number in the following series. 2, 4, 16, 256, —.

The foregoing questions represent only a few of the types of test items employed to measure the products of conceptual learning or its separate processes. The type of item employed depends, of course, upon the relation it is desired to test. If it is desired to test general ability to deal with relations, a number of test items of each type will be included. If it is desired to test specific ability, such as the ability to understand the part-whole relationship, only this type of item would be in-

cluded in an entire test. Test items may be arranged in different ways to achieve other purposes. It is desired at times, for instance, to measure the limit of one's ability to conceive. In this case, test items of different degrees of difficulty are included and arranged in the order of increasing difficulty. By carefully selecting test items in terms of the number of subjects able to deal with them, it is possible to arrange them in such an order. In other instances, it is desired to measure the speed with which different subjects can deal with items involving particular relations. In these instances, items of equal difficulty are used, and the subjects are instructed to solve or react to as many as possible in a given length of time.

The many purposes for which such tests are used in educational work include the following: (a) to measure general mental ability; (b) to compare abilities of individuals of different ages, school grades, sexes, amounts of training in particular fields, etc.; (c) to study the types of errors made by subjects in attempting to do abstract thinking; and (d) to determine the relative difficulty of different types of relations. The types of test items most commonly used for such purposes include the following: (a) classification, (b) opposites, (c) similarities, (d) analogies, (e) differences, and (f) various types of problems.

Tests of Number Concepts

In the previous chapter on conceptual learning, attention was called to the interest of educators in the growth and development of number concepts; in the ability of children to understand numbers in the abstract sense; and their ability to understand words and expressions that symbolize numbers. In order to study these problems, it has been necessary to devise numerous *tests of number concepts.* These exist in many different forms and are used for a large number of different purposes.

One type of number test consists in having pupils count forward, from 1 to 100, and backward, from 20 to 1. This test is intended to reveal the extent to which subjects have acquired number names in the proper sequence. Another type requires subjects to repeat forward or backward a series of numbers. Another type involves presenting groups of objects or symbols, such as sticks, marks, or dots, in groups of various sizes, and the scoring of subjects on their ability to conceive the number

of items in a group without counting. Other tests deal with the ability of subjects to classify objects in terms of number; that is, to think of number as a means of classifying any type of objects. It is often desirable to determine whether children have abstracted numbers from particular objects. A test for this purpose consists in having them count, and then for the tester to notice whether they say the number names without reference, or whether they point to separate objects. The ability to deal with numbers in relation to each other is the object of many other tests, including tests of the fundamental operations, such as addition, subtraction, multiplication, and division. These are not usually given to test number concepts, however, but they are given to test skills in using number concepts that are already formed. There are many tests that are designed to determine the extent to which subjects can understand words and expressions that symbolize numbers and number relationships. These consist of test items similar to those contained in vocabulary tests, and in various problems or exercises in which numbers are used. (7)

Association Tests

Another mental function which numerous tests have been designed to measure is association. This, it will be recalled, is the process of forming connections between elements of experience occurring at or near the same time. The function is usually studied in connection with memory, the process of reviving events which have been associated in the past. The two processes are the chief aspects of associative learning. The object of measuring them is usually that of determining the extent to which either is affected by numerous factors, and to discover differences between the abilities of individuals to engage in them. The character of any given test, therefore, depends upon the purpose it is intended to serve or upon the factor whose influence it is designed to measure. In this topic we shall call attention to several association tests. Memory tests will be discussed in a subsequent paragraph.

Tests of Sequence

Various tests have been used to measure the effects of sequence on the ease or difficulty of recall, or to show that the

order in which items are associated determines the efficiency with which they are revived.

One test used to study sequence is called the "alphabet test." It consists in having subjects say the alphabet forward and backward, as rapidly as possible. A record of the time required for each performance is made. A comparison of the time records of individuals, or of the averages for a group of subjects, reveals the effects of sequence on the recall of material which was learned a long time ago.

The effects of sequence on the recall of newly acquired material may be studied by giving the following tests: Subjects are given a list of items, such as nonsense syllables, words, letters, or numbers, and instructed to learn them in the order in which they appear in the list. Then they are instructed to recite the items forward and backward, and to make a record of the time required for each performance. The differences in time will reveal, of course, the relative difficulty of recalling newly acquired material in one or the other of the sequences.

A somewhat different test of sequence consists in having subjects learn a vocabulary of English and foreign words. They are instructed to learn one list of words and their foreign equivalents by associating the pairs from the English to the foreign word. The efficiency of learning by either sequence may be compared with that of learning by the other. The time required to learn one list, for example, may be compared with the time required to learn the other. Such tests frequently throw considerable light on some of the problems related to learning. (7)

Free Association Tests

Free or *uncontrolled association tests* are used in the field of memory, habit, and association to determine either the nature of the connections between mental elements or to measure the speed at which particular connections operate under various conditions. The tests usually involve a procedure that will induce subjects to revive an idea, or a series of ideas, without being influenced in any special way. In other words, the particular responses given by the subjects are the results of determining tendencies within the subject rather than the results of special factors suggested or provided by the tester. What is meant by such tests will be made clear by citing a few examples.

The following test has been used to study both the nature and the speed of associative processes in different subjects: "When I say 'now,' I want you to start with some word, any one you like, and keep on saying words as fast as you can, until you have given one hundred different words. I will tell you when to stop." Upon giving the instructions, the tester gives the signal to start; then he times the subject with a stop watch, and writes down each of the words that he gives. The time limit is three minutes. After the record is made, the subject is asked to help check the list of words to be certain that each is correct, and to explain, as well as possible, why unusual words occurred to him. The score for the test is either the number of words given in three minutes or the time required to give one hundred words. Other data yielded by the test include the words recorded and the explanations offered by the subject. Such data may be used for any or all of such purposes as the following: (a) to study the similarities and differences among the responses of different subjects; (b) to determine the speed of association, or the rate at which different subjects can think of words; (c) to determine the factors which cause individuals to hesitate or stop when they are saying words; etc. Subjects who take the test may be classified according to sex, age, family relationship, social status, school grade, etc.; so that each of these factors may be compared with the others in determining the character of the association.

A slight variation of this test consists in having the subjects start the series with a word or idea supplied by the tester, instead of leaving the subject to select his own starting point.

Norms for such tests have been worked out. They show the time and number of words given by subjects of different ages, and of various relationships. A list of words most commonly given by adults has also been compiled. It is possible by using these norms to compare the responses of any given subject with those of subjects in general. It is also possible to discover the tendency of individuals to think along given lines, as the tendency to think in terms of certain types of words, such as adjectives, nouns, action words, abstract words, concrete words, and numbers, or the tendency to think in terms of certain topics.

Still another variation of the association type of test involves

recording the responses of subjects to separate words. Usually, a list of one hundred selected words is used. The subject is given the list of words printed on a sheet of paper, and instructed to write on a blank opposite each the first word or idea that occurs to him and of which the stimulus word makes him think. When the responses are recorded for the entire list, they may be compared with a frequency table which shows the responses most commonly given by 1000 subjects previously tested. By making such a comparison, it is possible to find the average frequency of a given individual's responses. The test will reveal, therefore, the extent to which individuals tend to share experiences, the extent to which information is common, and the degree of originality of a given subject.

The free association test has been applied in fields other than learning and mental activity. It has been used also to discover emotional tendencies in individuals. As previously emphasized in our discussion of feelings and emotions, these types of behavior are frequently attached to objects and words which serve as their stimuli in the absence of an original stimulus. Consequently, it is possible to select words to which an individual will respond with some degree of emotional disturbance. Tests including such words have been used in discovering particular attitudes, special complexes, and even innocence and guilt in regard to crimes and misdemeanors. These conditions are revealed by the types of responses that individuals exhibit when key words are presented, such responses being unusually long or quick, peculiar in meaning, etc. Too, the subject may unwillingly exhibit some degree of confusion. (7)

Forced Association Tests

A *forced* or *controlled association test* requires the subject to give a restricted or designated type of response to one or more stimulus words or ideas. There are many specific tests of this type used for a large variety of purposes.

A partially controlled association type of test is one in which subjects are asked to give a certain number of words related to some field of thought or activity. For instance, subjects might be asked to give twenty words related to one or the other of the following fields; fruits, vegetables, athletics, streets, etc.; or they might be asked to say twenty words that rhyme, or that

describe a given object. Usually, a starting word is given by the tester, and the subject continues to respond in terms of the suggested or established mental set. The results of such a test will reveal, of course, the ability of individuals to think in a given field, the nature of their thinking in many respects, and also the speed with which they think along the lines indicated.

Typical tests of the controlled association types include various *logical relations* and *substitution tests*. *Logical relations* tests require the subject to react to particular stimuli, usually words, with ideas related to them in various ways. The relations that have received most attention in the literature of mental tests are part-whole, genus-species, opposites, agent-action (subject-verb), substance-attribute (noun-adjective), cause-effect, and various mixed relations.

The purpose of such tests is usually that of determining how quickly and accurately different subjects can react to a series of stimuli in specified ways. The quickness of responses is determined in two ways: either by measuring the reaction time or by taking the time required to give orally or in writing the specified responses to all the separate items in a list. In the latter procedure the time is usually taken with a stop watch, and the total time divided by the number of responses.

The results of such tests are usually studied in relation to age, sex, intelligence, school progress, and race. Most of the tests are valuable indices of mental alertness and of ability to deal with relations of one type or another. The value of a particular test, however, depends on the selection of the stimulus words in view of a given purpose.

The *substitution* type of test is usually in the form of a symbol-digit test. In this the purpose is to measure the rapidity with which new associations are formed by repetition. The subject is called upon to substitute for one set of characters, such as letters, digits, and geometrical forms, another set according to a given plan. Usually the test consists in giving the subject a printed key and asking him to spell out words by substituting the digits or symbols for the letters they represent.

There are many variations of the test, several of which have been fairly well standardized.

This type of test has been used to study the shape of the learning curve, to study the effects of varying amounts of prac-

tice, and to discover the extent of individual differences in this type of learning. The results are usually studied in relation to age, intelligence, physical condition, and various other factors. (7)

TESTS AND METHODS FOR STUDYING MEMORY

Memory Tests

Among the great variety of tests of specific mental functions that have been devised, *memory tests* appear very frequently. They are used for collecting data in studying the memory process and the factors that influence it, and in measuring memory ability for various types of material. They have proved very helpful in isolating and evaluating the factors that affect associative learning. Various types that have been used as devices for measuring memory products are described below.

Method of Complete Mastery.

The *method of complete mastery* for measuring memory products consists of repeating items or selections until they can be recalled and reported verbally or in writing, without error. The list may be composed of nonsense syllables, words, sentences, or a poem or prose selection. The score is the number of presentations or repetitions, or the amount of time, or both, required for complete mastery.

This type of test is used for a variety of purposes, such as determining the relative difficulty of different types of material, the value of different methods of learning, and the rate at which individuals can memorize.

Method of Recognition.

The *method of recognition* includes the presentation of a number of objects, syllables, words, sentences, etc., for initial impression or registration, followed by a second presentation with similar or different items, to determine how many of the first items can be recognized as having been seen or heard before. The items may be presented orally or visually. The score is the number of items recognized.

This type of test has been used in measuring memory for colors, letters, syllables, words, tones, and various concrete objects.

Method of Identification and Selection.

In this method the subject is required to compare an object of immediate experience with one of past experience of the same general type, and to report whether the two are identical or different. For instance, the tester may sound a note of 256 vibrations per second, then a note of 384 vibrations, and ask the subject to report whether they are the same or different. Other types of stimuli may be used.

This type of test has been used in determining the effects of short time intervals on memory and in studying memory for different types of material. It has also been used extensively in the study of sound.

Method of Reconstruction.

The *method of reconstruction* involves presenting a series of stimuli in a definite order; presenting the same stimuli in another definite or chance order, after an interval of time; and then asking the subject to re-arrange the stimuli in the original order. The score is the time required or the number of items arranged correctly, or both.

This type of test has been used in studying the effects of sequence and retroaction on memory for various types of material.

Method of Right Associates.

A very common method of testing memory is that of presenting pairs of items to be associated; then one member of each pair is presented a second time, and the subject is expected to supply the missing member.

This method can be used in studying the rate of forming associations between similar or different pairs.

Memory-Span Tests

The *memory-span test* is similar to the perception-span test. It consists of determining the maximal length of a series of objects, letters, words, numbers, etc., that the subject can reproduce after a given number of presentations. Usually, the tester begins by presenting a short series which the subject can easily reproduce; then he presents longer and longer series in successive order, until errors appear in reproduction. The subject

may be required to reproduce the items either in forward or backward order. The score may consist of the largest number of items reproduced from any single series or of the total number of items reproduced from several series.

This type of test has been used more extensively than any of the other types described. It was a favorite test of memory ability for a number of years for the purpose of revealing individual differences; and it has been used in the study of memory for many different types of material, such as lines, colors, geometrical designs, letters, words, and nonsense syllables.

Memory Apparatus

The study of memory, or the testing of memory products, is often facilitated by means of laboratory apparatus for controlling the length or rate of exposure. One device is the *memory drum* of which there are many types. One type consists of two cylinders, one enclosing the other. The inside cylinder carries the material to be exposed, and is made to move at regular intervals by an escapement mechanism. The outside drum contains apertures through which the materials may be seen when the inside drum stops. The speed of exposure is controlled by increasing or decreasing the rate of movement of the inside drum. The subject sits in front of the instrument, views the material being exposed, and reacts according to the directions given by the experimenter.

Another type of instrument employed in the study of memory is the *tachistoscope*. This is a device for exposing printed materials, such as digits, letters, syllables, and words, for constant lengths of time. The exposure time may vary from 1/1000 of a second to several seconds, depending on the type of tachistoscope. A simple tachistoscope may be made of a photographic shutter and lantern slide projecture. The shutter is placed before the lens of the lantern and the materials are exposed from lantern slides for any period of time desired.

This type of apparatus has been used not only in the testing of memory but also in the testing of attention, perception, and other mental processes.

EXERCISES

1. Explain what is meant by the *method of impression* and the *method of expression* used in connection with tests of feeling. Illustrate.

2. Explain the terms *general emotionality*, *extroversion*, and *introversion*.
3. What significance has the information derived from tests of emotions?
4. Explain what is meant by *fluctuations of attention*, *scope of attention*, and *determiners of attention*. Illustrate each of these terms.
5. What do tests of attention indicate regarding the general nature of attention?
6. What determines the specific type of test to be given in measuring perception? Describe or illustrate two types commonly used.
7. Why would information obtained from tests of perception be of particular value to the classroom teacher?
8. What use is made of the information obtained in *vocabulary tests?* Of the information obtained in *tests of relations?*
9. What is meant by *free* or *uncontrolled association tests* and by *forced* or *controlled association tests?* Explain and illustrate each.
10. What relationship is there between successful teaching and the measurement of specific mental functions and abilities? Why?

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CHAPTER XIX

TESTS OF GENERAL MENTAL ABILITY AND APTITUDE

INTRODUCTION

Purpose of the Chapter

The tests described thus far, it will be recalled, were concerned mainly with the measurement of specific functions and abilities. The tests that are to be described in this chapter are designed to measure general mental ability and special aptitudes. In describing these, an effort will be made to indicate the nature of the traits measured, the problems involved in measuring such traits, the types of tests employed, the nature of specific types of tests, and the uses and values of different scores or results.

Classifications of Tests

General Types

Tests of mental ability are usually classified into two general types: (a) intelligence tests, and (b) special aptitudes tests. Intelligence tests are designed to measure intelligence or general mental ability, and special aptitudes tests are designed to measure the aptness or potential ability of individuals to engage in special fields of mental activity, such as professions and trades.

Basis of Classification

The two types of tests are based on a relatively modern view of the nature of intelligence. In the early days of mental measurement, mental activity and ability were regarded as a composition of specific abilities described in the previous chapters. Consequently, the construction of tests followed the general plan of isolating particular functions and measuring the abilities of individuals to perform them. The result of this plan of work

was the construction of the numerous specific tests described earlier. When it was desired to measure "general ability," a number of specific tests were given and the scores averaged; the resulting average being regarded as indicative of an individual's general mental ability.

In 1904, Alfred Binet, a French psychologist, was confronted with the task of devising a measuring instrument that could be used in selecting feebleminded children in need of institutional care. By actual trial, he found that the specific tests of mental functions, such as the tests of sense discrimination, attention, and memory, could not be used for his purpose. Consequently, he began to try to measure general ability or intelligence, which he regarded as a composite of various complex mental traits functioning as a whole. With this idea of intelligence as a basis, Binet constructed a scale which included tests of three or four kinds of memory, language comprehension, perception and apperception, knowledge of common objects, free association, constructive imagination, ability to compare concepts and to see contradictions, to combine fragments into a unitary whole, to comprehend abstract words, and to meet various other new and novel situations. By giving a series of such tests to children of different ages, Binet was able to determine the relative difficulty of different tests and to arrange them according to particular age levels. He did this by selecting tests which were passed by two-thirds or three-fourths of a group of unselected children. A major result of his work was the Binet-Simon Scale of Intelligence, published in 1908. This scale was the first of hundreds to be constructed later.

A second line of investigation dealing with the measurement of specialized abilities gave rise to the second type of tests indicated above. These are the tests of special aptitude designed to reveal the native ability of individuals to engage in certain broad fields of mental activity. These tests are based on the assumption that individuals inherit the capacity to succeed in such broad fields as school work, vocations, trades, music, art, etc. In this field tests are constructed which will predict the probable success or failure of persons expecting or desiring to enter various lines of work. Here an effort is made not to measure general intelligence, but rather special ability to acquire the functions involved in limited though broad fields of endeavor.

The two lines of investigation have resulted in the construction of the two types of tests indicated above. These will now be described and illustrated.

INTELLIGENCE TESTS

First, attention will be called to certain assumptions and problems underlying the construction of intelligence tests; and second, we shall notice various types of tests and their nature, advantages, disadvantages, and uses.

Assumptions and Problems

Assumptions

The first assumption underlying the construction of intelligence tests is that the factor to be measured is an inherited capacity capable of being measured by means of standardized instruments. Yet, in measuring it, test items have to be employed which call into action mental processes that are the products of experience and training. Consequently, a second assumption has to be made that all subjects of a given chronological age have had equal opportunities to acquire the functions. Otherwise, a given test would not measure a native capacity but an acquired ability. Finally, it is assumed that a general trait can be measured by different examiners, provided test conditions are adequately controlled and a standard measuring instrument is employed. By working along the lines suggested by these assumptions, test makers have evolved a large number of tests and scales which appear to fill a real need in the schools.

Problems

Some of the problems involved in test construction may be stated briefly as follows: (a) selecting test items that will call out complex mental performances which all individuals have had equal opportunities to acquire and which are suitable for subjects of different ages or grades; (b) arranging the test items in the proper sequence, as from the least to the most difficult; (c) devising directions for administering the test so that it can be given by different examiners and taken by subjects of different ages; (d) providing convenient and easy ways of recording

responses; (e) selecting test items that are interesting and challenging to pupils for whom they are intended; (f) devising accurate and economical methods of scoring; (g) constructing equivalent forms of the same test, or similar tests that will measure the same trait, so that a given individual or group may be retested; and (h) establishing norms by which the performance of an individual or group may be evaluated. A careful solution of these problems, it is generally believed, results in the construction of *valid*, *reliable*, and *objective* measures of intelligence. (12)

Types of Intelligence Tests

The hundreds of intelligence tests in use may be classified from a number of standpoints. When they are classified from the standpoint of the number of subjects that may be tested at one time, there are two types: (a) individual and (b) group tests. If classified according to the form in which they are presented, there are three types: (a) oral, (b) written or printed, and (c) non-language or performance tests. If classified according to the school grades for which they are intended, intelligence tests are of the following types: (a) preschool, (b) kindergarten and primary, (c) elementary-school, (d) high-school, and (e) college tests. Some tests are intended for a wider range of ages or grades, and some for all ages. These latter are usually designated as *survey* or *mental maturity tests*. If classified according to different types of intelligence, there are two types: (a) tests of concrete, and (b) tests of abstract intelligence.

Since these classifications represent different points of view of the same things, there is considerable overlapping among them. Consequently, we shall not attempt to discuss each type in detail. We shall confine our discussion here to individual and group tests, and describe the other classes under these headings.

Individual Tests

GENERAL DESCRIPTION. Individual tests are administered privately to one person at a time. They are usually arranged in the form of scales, following the Binet plan, according to year levels; so that easier tests are given to younger children and more difficult ones to older children. If a child passes the tests up to and including those of his level, he is said to have normal

*intelligence. If he fails to pass the tests intended for his age level, the child is regarded as dull or feebleminded, according to the number that he passes. One who passes tests above his age level is regarded as superior, very superior, or genius.

This method of testing makes it possible to assign to each subject his mental age (M.A.) and to calculate his intelligence quotient (I.Q.). For instance, if a seven-year-old child passes all tests up to and including those intended for eight-year olds, his mental age is eight years. The I.Q. is found by dividing the mental age by the chronological age. This seven-year-old child would have an I.Q. of 8/7 or 114 plus. That is, he is brighter than the normal I.Q. of 100.

Tests which are constructed, administered, and used in the foregoing manner may be divided into two classes: (a) non-language or performance tests, and (b) oral or language tests. A discussion of each of these types and a description of one or more examples will reveal their nature, purpose, and uses. (9)

NON-LANGUAGE OR PERFORMANCE TESTS. Non-language—*performance tests* and *scales* are so called because the subject responds to the situations presented by performing a muscular act. What the subject is to do is indicated by the tester either by oral instruction or by pantomime or signs. The test items are usually presented in concrete form, such as a picture or diagram that the subject can see, a puzzle to solve, or a set of blocks to place in certain positions. In one test, for instance, the subject is instructed to assemble the parts of a picture as quickly as possible. In another, he is asked to solve a mechanical puzzle. In another, he is instructed to insert pieces in a *form board* from which they have been cut. In still another, he is told to make a given object, such as a man, out of disassembled parts. Several such tests, usually ten or more, arranged in serial order from the easiest to the most difficult so as to form a scale, are presented; and a record is made of the successes and failures and of the amount of time required to complete each task. When such data are used as scores, and when the scores of individuals or groups are compared with established norms, it is possible to evaluate their separate or combined performances.

Performance tests are used to measure *concrete intelligence*, or the ability to see relations and solve problems presented in con-

crete form. They are employed mainly in testing children who do not understand English, such as the foreign-born, and in testing the deaf. In many cases, however, they have been employed in testing normal, English-speaking children. This is done particularly in determining whether concrete and abstract intelligence are aspects of native ability and whether the language factor is important or unimportant in the measurement of intelligence. (9)

INDIVIDUAL LANGUAGE TESTS. The *individual language* test is presented orally and privately. Though language is employed, care is taken to make each test easy to understand and to be certain that the child understands each problem, when it is within his mental grasp. This caution overcomes, to some extent at least, the possible effect of using an acquired function in testing a native ability. In this type of test, the problem may be presented in either concrete or abstract form. The usual custom is to include both types of problems, using concrete problems for the younger and more abstract ones for the older subjects. Each test or test item usually requires the subject to employ several mental functions to react to it properly.

A few examples of the tests contained in the famous Stanford Revision of the Binet Intelligence Scale will reveal the nature of the problems:

Age 3. Naming objects. The examiner shows the child a key and asks, "What is this?" Then he shows a penny, a closed knife, a watch, and a pencil, asking what each is. If three responses are correct, the test is passed.

Age 4. Comprehension. The examiner asks the child three questions: (a) "What must you do when you are sleepy?" (b) "What ought you to do when you are hungry?" (c) "What ought you to do when you are cold?" If two of the three questions are answered correctly, the test is passed. In order to enable the examiner to know whether particular answers are correct, examples of satisfactory answers are provided on the record blank that accompanies the Scale.

Age 6. Naming missing parts. A standard card is shown with faces having certain parts missing. The examiner says, "There is something wrong with this face. It is not all there. Part of it is left out. Look carefully and tell me what part of the face is not there." Credit is given if three out of four missing parts are named.

The Stanford Scale contains about ninety such tests. Each differs from the other, of course, but each is designed to deter-

mine whether the subject can engage in one or another of the complex mental processes. Most of the tests seem to stress the abilities of conception and imagination, or combinations of these, but some stress memory and others associative processes. Each of the tests is presented and responded to orally, but some few are responded to by performing a variety of physical acts. Not all of the tests are given to one subject but only a sufficient number to locate his mental age. The examiner usually determines the subject's chronological age and begins with the tests designed for children one year below this age. If the child succeeds in passing these, the examiner proceeds on up the scale until he reaches an age level in which all the tests are failed. Since there are six tests for each year, each test counts two months on the mental age.

Advantages and Disadvantages of Individual Tests. Though the examples from the Binet Test may suffice to illustrate the problems involved in constructing and using individual language tests, it may be observed in passing that the original Stanford Revision of the Binet Scale has recently undergone a complete revision. A 1937 Revision contains 190 tests intended for all ages from one to eighteen years; and the tests are thought to be more interesting to children than those contained in the 1916 Revision described above. The constant revision of such instruments illustrates the disposition of workers in the field to correct errors in testing and to strive toward the perfection of particular instruments.

The advantages of individual intelligence tests grow out of the fact that a private, personal examination is usually more searching and accurate than a public impersonal one. Individual tests are, therefore, usually regarded as being the most accurate measures of intelligence now available. Additional advantages may be summarized as follows: (a) By observing the child's total reactions, the examiner has an opportunity to note other traits than intelligence, such as the tendency to co-operate, to give and sustain attention, to be afraid or ill-at-ease, to stick to a task, and to make quick or slow movements and decisions. (b) The examiner has opportunities to analyze causes of failure on particular tests when these are due to other factors than intelligence, such as illness, and emotional disturbance. (c) By coming in close personal contact with the child, the examiner

is often able to discover various physical defects and handicaps, such as defective seeing and hearing, or various deformities. (d) The examiner finds it possible to enlist the child's interest and to secure his best effort.

While individual tests possess the foregoing advantages, they have at least two practical disadvantages: (a) In order to give them and obtain reliable scores, the examiner must be specially trained. That is, he must be thoroughly familiar with the tests and scale as a whole; he must know how each part is to be given and how to secure the attention and support of the subject; and he must be familiar with the criteria by which every response is judged as a pass or failure. These requirements are a disadvantage in that relatively few school executives and teachers have had sufficient training to give and interpret the results of individual tests. (b) The administration of individual tests requires a considerable amount of time. The Binet Scale, for example, requires from forty-five minutes to an hour. School authorities, as a rule, do not have sufficient time to carry forward an individual testing program. (9)

Group Intelligence Tests

General Character. Group intelligence tests, as the name implies, are designed to test a number of individuals at a time, such as a class of pupils in school. They usually consist of a series of test items similar to those found in individual tests, except that the responses can be recorded on paper by the subject. The testing instruments are, therefore, in the form of single sheets or test booklets that can be distributed to the subjects composing the group to be tested. Some group tests contain verbal questions, problems, and exercises to be read and marked in special ways; others contain pictures, diagrams, mazes, etc., which are worked in prescribed ways. The object, in either case, is to secure records that can be scored objectively at the convenience of the examiner. Some group tests contain written directions for the subjects to read and carry out; others are presented in oral directions given by the examiners and executed by the subjects; and still others involve directions presented by signs or in pantomime by the examiners. The first type is to be used with subjects who can read; the second is intended to isolate the factors of reading; and the third elim-

inates all language factors and they can be given to subjects who cannot understand English or who cannot hear.

ADMINISTRATION. The administration of a group test involves a relatively simple procedure. First of all, the examiner is supplied with a booklet containing detailed directions for giving each test, for scoring responses, and for interpreting individual scores. The chief task of the examiner is that of getting acquainted with the directions and with the tests, and of following the directions both implicitly and explicitly. The procedure of administering the test to a given class involves: (a) distributing the booklets; (b) reading and explaining the directions; (c) showing subjects how to record responses; (d) starting and stopping the subjects at the proper time; and (e) seeing that each pupil is alert to the individual tasks and that he is following directions to the best of his ability.

CHARACTER OF TEST ITEMS. As suggested above, the test items contained in group intelligence tests are very similar to those contained in individual tests. As a matter of fact, many group tests include items selected from the Stanford Revision of the Binet Scale, or items that are very similar to the ones that are in that scale. The reason for this marked degree of similarity is that both types of test items are intended to measure native rather than acquired ability.

The essential difference between the test items in individual and group tests is in their form. This difference consists in presenting the test items in group tests so that the responses can be recorded by the subjects rather than by the examiner. The items are selected by a trial-and-error procedure, so that the scores on a group test will correlate highly with scores obtained by known measures of intelligence.

The test items most commonly employed in group tests usually fall into the following types: analogies, classifications, number series, reasoning problems, geometric patterns, best answers, similarities, opposites and common attributes. Such items as these are selected in order to secure a score representative of a large number of the different aspects of intelligence.

The form in which the test items are presented varies according to the following types of tests: completion, identification, matching, multiple choice, opposite, substitution, true-false, disarranged sentences, etc. A few samples representing these

different types of tests will indicate the manner and the ease with which subjects may record their responses and the ease with which a group of items may be scored.

Completion: A cow gives____.

Common attributes: Underline the two words that tell what a pig always has—pen, corn, mouth, tail, spots.

Similarities: Draw a line under the pair of words that are similar in meaning—high and low, large and small, pretty and beautiful, several and few.

Best answers: Check the best answer to this sentence, "A good boy deserves—(a) punishment, (b) scolding, (c) praise, (d) money."

Sentence meaning: Answer "yes" or "no" to the following question: Is an alloy a kind of wood? Yes. No.

Analogies: Dress is to wear as water is to—run, drink, flow, drown, cook.

Classification: Cross out the word that does not belong in the series: Henry, Jane, John, Evelyn, Bill, death, Arthur.

Number series: Continue the series with two numbers: ¼, ½, 1, 2, 4, 8, ____, ____.

Test items stated in such forms as these are intended to be objective; that is, to be answered by a definite word or act, so that two persons scoring a test or scale will always arrive at the same score.

ADVANTAGES AND DISADVANTAGES OF GROUP INTELLIGENCE TESTS. The chief advantages of group tests are the following: (a) Since a large number of individuals can be tested at once, group tests save time on the part of examiners, making it possible to carry on a testing program in almost any school. (b) They can be given by examiners who have not found it possible to secure rigid training in the use of tests. Nevertheless, it is impossible for persons to give tests who have not had some training in this field.

The disadvantages of group tests may be apparent already. They may be summarized as follows: (a) They are less accurate than good individual tests. (b) The validity and reliability of group tests cannot be determined beyond the range of statistical probability. (c) Children are frequently indifferent or careless in regard to taking group tests. When they are not being dealt with as individuals they do not always put forth their best efforts. (d) There are frequent language difficulties that cause particular pupils to fail given items with which

they are mentally able to deal. (e) Frequently, there are distractions when the instructions are being read that prevent children from knowing what to do with particular items. (6)

Criteria of Intelligence Tests

By criteria of intelligence tests is meant the qualities or characteristics of a test that make it a desirable instrument. It is necessary to call attention to these matters for the reason that many so-called intelligence tests are poor if not worthless instruments. The criteria most commonly observed are the following: (a) objectivity, (b) validity, and (c) reliability. Though these terms have been defined previously, some discussion of them at this time will not be out of place.

Objectivity

This term refers to the extent to which administering and scoring a test are free from the personal judgment of the individual who gives and scores it. In other words, an objective test can be given and scored by any number of different persons and the scores obtained will be the same. Objectivity is attained by having "fool-proof" directions for administering and scoring, and by the use of objective type test items. On the whole, present-day intelligence tests are highly objective.

Validity

This term refers to the degree to which a test measures that which it purports to measure. This is important in that it is easy to include test items that measure other traits. The validity of a test is usually established by correlating scores obtained from it with scores obtained from another instrument of known validity. The validity of most group tests, for instance, is ascertained by correlating their scores with scores obtained by the Binet Scale which is generally conceded to be a valid scale. The best way for a teacher to determine the validity of a test that she might want to use is to study the ways in which efforts have been made to establish its validity. These are usually set forth in the directions that accompany each test. (9)

Reliability

This refers to the accuracy with which a test measures what it purports to measure. Reliability is usually determined by

correlating the scores obtained by two different applications of the test to the same children. The children may not make the same score the second time that they make the first, but if the test is reliable, they will tend to make scores of the same rank. In other words, the brightest child will likely not only make the highest score the first time the test is given, but he will also make the highest score the second time it is given. If this is true in the majority of cases, there will be a high correlation, and the test will be judged as reliable. Another means of testing reliability is to correlate the scores obtained by two forms of the same test applied to the same group of subjects. A high correlation of this kind indicates a corresponding degree of reliability.

The teacher will not be able to do all this, of course, but she can ascertain the data obtained by persons who constructed the test. These data are also presented, as a rule, in the manual of directions accompanying each test. (9)

Uses and Purposes of Intelligence Tests

The original purpose underlying the construction of intelligence tests was the selection or discovery of feebleminded children. This very important usage is still observed in selecting cases for institutional care. For this purpose it is always advisable to use individual tests, since in practice, these have proved far more valuable than have group tests.

Since intelligence is closely related to ability to learn, it has long been known that knowledge of the I.Q.'s of children is useful to school authorities and teachers. Along with other measures, intelligence quotients and mental ages have been used for the following purposes: (a) classification, (b) grading, (c) prognosis, (d) guidance, and (e) diagnosis. Each of these may need some explanation. (1, 6)

Classification

One of the principal uses made of intelligence test results is that of classifying pupils into ability groups for instruction. That is, in some school systems, before pupils are assigned to particular classes, they are all given intelligence tests. Then, on the basis of the results, the pupils are divided into two or more levels, usually a slow or dull group, a mediocre group,

and a bright group, for each grade. The dull and bright groups generally consist of the lowest and highest 20 per cent, respectively, and the mediocre group consists of the middle 60 per cent of the pupils tested, for this is about the way normal groups are naturally divided. When the pupils are selected on these bases, the teacher can suit her methods, materials, grading system, etc., to the needs of the group in terms of its degree of brightness. In actual practice, dull pupils are given only minimum essentials or a simplified course; mediocre pupils are given a regular course; and bright pupils are given an enriched course. This is done because pupils of high intelligence can learn a greater variety as well as a greater amount of material. Frequently, the bright child is provided for by means of rapid promotion, but this practice is recommended only when the child is sufficiently mature in other ways to associate with pupils in grades higher than his age-grade level. (1)

Grading

The term "grading" in the present sense refers to placing children in proper school grades. The old basis for grading was chronological age; that is, most grades were made up of children having nearly the same chronological age. With the advent of intelligence tests, however, this basis of grading has been gradually abandoned in favor of mental age. It is now assumed in general that children having the same mental ages should be placed in the same grades. This basis of grading results in "homogenous grouping"; that is, the pupils in a given grade will have about the same mental abilities. Such a basis has one objection: it tends to place young bright pupils in the same grade with older ones less bright. Since this is unavoidable by any system of grading, except when chronological age is used as a basis, it is desirable to separate the young and old by further dividing each grade into classes, such as the dull, normal, and bright groups suggested above. Grading may in this way be determined on the basis of mental age, and homogenous grouping on the basis of intelligence quotients of pupils in the same grade.

Prognosis

Another use made of intelligence tests is *prognosis*. By this is meant the forecasting or predicting of future possibilities of

pupils. It is generally assumed that bright pupils have greater future possibilities of dealing with school work in general than have dull pupils. It has been shown, for instance, that dull pupils tend to fail the more abstract school subjects, and because of failure to drop out of school. In order to offset these tendencies, schoolmen usually determine the mental abilities of pupils and suggest the courses of study that they should follow because of these abilities. Bright pupils are usually advised and encouraged to pursue the usual science and arts courses, while dull pupils are advised to pursue the manual arts course. Such advice is given because intelligence tests yield a fairly accurate estimate of what pupils will subsequently accomplish.

Guidance

The prognostic uses of intelligence tests suggested in the preceding paragraph are frequently designated by the term *educational guidance.* Still another use made of intelligence tests is that of *vocational guidance,* which consists partly of advising young people regarding the choice of a vocation or profession. Intelligence tests have proven of value here in that individuals of low intelligence are rarely found in the professions. In other words, it is quite certain that a very dull person will never make a success in trying to follow any of the learned professions. Because of such facts, knowledge of mental ability assists advisers in helping children avoid occupations in which they are likely to fail, and in choosing those in which they will most likely succeed. Nevertheless, in all guidance work, great care must be exercised not to rely altogether on intelligence tests. Intelligence is only one factor that is to be considered. A guidance program must be based on the results of various other measures and types of information. (11)

Diagnosis

Intelligence tests often prove helpful in diagnosing pupil difficulties, failures, special abilities and the like, enabling the teachers to know what to do with particular pupils. Bright pupils, for example, are capable of doing more and better work than dull pupils. If a bright pupil does poor work and little of it, the teacher knows that the failure is not due to inability. She can begin to look for other difficulties. Moreover, if a

pupil proves to be incapable of doing school work, an individual intelligence test will reveal whether this incapability is due to the lack of sufficient intelligence and whether the pupil is in need of institutional care. Sometimes an apparently bright, capable child develops into a constant disturber or mischief-maker. The application of an intelligence test may reveal that the child is a genius who is bored with the ordinary tasks of the school and in need of special assistance toward finding more interesting and challenging tasks. Intelligence tests often reveal, both positively and negatively, a great many special problems confronting teachers.

SPECIAL APTITUDE TESTS

General Description

Definition and Purpose

Another field of measurement in which educational psychologists have been considerably interested, particularly during the last decade, is the field of special aptitude testing. This field deals mainly with the construction and application of tests designed to discover the traits essential for the successful performance of the tasks peculiar to any special occupation, such as philosophy, science, art, literature, business, skilled trades, and the like. These tests, generally known as *special aptitude tests*, are similar to intelligence tests in that they are designed to measure native rather than acquired traits; but they differ from intelligence tests in being restricted to particular types of abilities. Whereas intelligence tests are designed to measure an ability that is exercised in any field of mental activity, aptitude tests are designed to measure the capacities demanded by work in a limited though somewhat broad field of activity. In fact, the purpose of any given aptitude test is that of measuring the potential ability of a given subject for learning or engaging in a given type of performance. Thus, all special aptitude tests are given for the purpose of prognosis or for the purpose of revealing the extent to which one is naturally fitted for a given occupation or special type of service. (5)

Problems of Construction

The entire field of special aptitude testing is based on the assumption that special aptitudes are inherited. This assump-

tion is based, in turn, on observation and measurement. It has been shown, for example, that individuals who are subjected to the same amounts of instruction and training in any special field reveal marked differences in attainments. For instance, if two individuals of the same degree of intelligence and motor ability were subjected to the same amounts of instruction and training in music, one might become a skilled musician and the other reveal little or no progress whatever. Findings of this kind in the actual application of general tests have convinced psychologists that individuals inherit a number of special aptitudes.

Proof of the inheritance of special aptitudes is not the only problem with which test makers have been concerned. Another and more difficult problem is that of discovering the extent or amount of the aptitude. This is a difficult problem for the reason that it is not easy to isolate inherited from acquired traits. The usual practice followed in overcoming the difficulty is that of constructing tests to be given to individuals who have had no opportunity to exercise the aptitude it is desired to measure. A stenographic aptitude test, for example, may be given to a subject who has never seen a typewriter nor a specimen of shorthand but who wishes to know whether he possesses the capacity to become a successful stenographer. This practice tends to isolate the inherited capacity, of course, in that the effects of previous experience, training, or instruction are reduced to a minimum. In spite of this practice, however, it appears to be almost impossible to find any ability that is totally unaffected by such factors. It has been found, for instance, that if an aptitude test is given to two individuals of equal aptitude but unequal amount of training, the person who has had the greater amount of training in the functions tested will make the higher score. This fact indicates that training and experience help to develop and increase the functional amount of a given aptitude. Nevertheless, if two persons of different aptitude have had equal amounts of training, the person with the greater aptitude will make the higher score on an aptitude test. Thus the solution of the problem of measuring aptitudes seems to depend in part upon the selection of functions that have not been specifically exercised, and upon the selection of individuals who have had the same amount of exercise in the same functions.

Further problems of aptitude testing are those involved in the selection of test items that can be done by persons without training and yet which will be indicative of the relatively general or specific capacities involved in a given type of performance. This problem is attacked either by selecting test items that will measure the essential activities in a given occupation or by selecting items that will isolate and measure separately the component capacities and traits supposed to contribute to success in a given undertaking. The first type of solution results in a test which confronts individuals with a "miniature" of the larger situation in which he might be found; the second results in an "omnibus" type of test in which numerous specific functions are measured and the results combined into a single score taken as indicative of the total aptitude. (4, 5)

Types of Aptitude Tests

There are many ways of classifying special aptitude tests, two of which will be presented here. First, they may be classified according to the types of aptitudes it is desired to measure. From this standpoint, we find such sub-types as the following: (a) scholastic, (b) vocational, and (c) artistic aptitude tests. Second, they may be classified according to the arrangement of the test items. This basis of classification, which applies also to achievement tests which are to be described later, yields the following types: (a) power, (b) speed or rate, (c) cycle or spiral, and (d) scaled tests. Each of the sub-types indicated may now be described and illustrated.

Scholastic Aptitude Tests

Any test that will enable educators to predict the probable success or failure of pupils in school is an aptitude test. This type includes, therefore, the general motor ability and intelligence tests previously described. Usually, however, scholastic aptitude tests are more restricted in range, including problems and exercises similar to those that will be met with in particular subjects. Attention may be given to samples of this type.

SCIENTIFIC APTITUDE TESTS. One author has constructed tests designed to analyze scientific aptitude into such elements as clarity of definition, suspended judgment, experimental bent, detection of fallacies and contradictions, reasoning, accuracy of

systematic observations, induction, deduction, generalization, and caution. A number of test items intended to measure each of the elements is included in the test; so that a score on the test as a whole is indicative of the individual's ability to engage in scientific thinking. The results of this type of test are used as a basis for advising students regarding the selection of courses in science or the selection of future endeavors involving scientific thinking. A student who makes a low score on such a test should obviously need to refrain from following a line of work in which the abilities measured play a prominent role. (7)

College Freshman Aptitude Tests. Some colleges and universities employ aptitude tests as a basis for college entrance and guidance. These tests are designed to reveal whether a given student has the ability to succeed in college. The test items employed usually include the several types found in intelligence tests and others selected from various college subjects. Most tests of the latter type emphasize the ability to read different types of material and the ability to solve problems in the sciences usually taught in college. When problems of this kind are presented, a sufficient amount of instruction is presented with each problem to enable the apt student to solve it without special training. The scores on this type of test are frequently used not only to determine whether students should be permitted to enter college, but also as a basis for guiding students in the selection of courses. They may be used, further, as a means of determining or inferring causes of relative success and failure. Students who make extremely low grades on aptitude tests may or may not make high grades in their courses. In other words, native aptitude is one of the very important factors in determining the degree of achievement found among college students.

Achievement Aptitude Tests. Achievement tests measure abilities that are the products of instruction and training, but they may also reflect individual differences in scholastic aptitude. This is particularly the case when it is known that all individuals have had approximately equal opportunities for instruction and training in a given course. Assuming that this is the case, the differences yielded by an achievement test are due not to instruction and training but to differences in aptitude. Though this is a dangerous assumption to make, an indi-

vidual's score on an achievement test given at one stage in a course of study usually indicates somewhat the size of the score that he will make on subsequent tests. This occurs when the individual is working and learning in accordance with his natural ability. Nevertheless, achievement tests are not used very frequently as measures of special aptitude. They are employed rather to measure the results of instruction and learning.

OTHER SCHOLASTIC APTITUDE TESTS. The scope of the treatment here does not permit a detailed discussion of scholastic aptitude testing. It is enough to say that a large number of tests are now available which educators are able to use as a help in predicting probable success and failure in almost all of the school subjects. These include a number of language tests, such as English usage, composition, and debating; various mathematics tests; and other tests of special fields of scholastic activity. Since special tests are more detailed in character, they are more accurate than intelligence tests as a means of determining active scholastic aptitude of special types. (5)

Vocational Aptitude Tests

By *vocational aptitude tests* is meant measuring instruments constructed to give indications of traits essential for success in various occupations. Some vocational tests are constructed to reveal the degrees of progress attained by workers in service, but the aptitude tests are intended for persons who have not begun work. They are constructed to measure native capacities and traits that are the potentialities for learning and development in a given profession or trade. In constructing such tests, therefore, it is necessary to include items which will reveal symptoms of vocational aptitude or items which will measure the specific capacities which are exercised. Both types of tests are frequently employed.

Since considerable work has been accomplished in the field of testing, it would require a volume to describe all of the tests that have been constructed. Attention will be given here, therefore, only to a few representative types. As examples of the nature, specific purposes and uses of these tests, the types indicated below are described and illustrated. (5)

INTELLIGENCE TESTS. Though not intended primarily as measures of vocational fitness, intelligence tests are frequently

employed in the selection of personal lines of work. They are used for this purpose because high intelligence is known to be an essential requirement for many occupations, particularly the professions. A study of the personnel records of the United States Army reveals a number of interesting facts which support this observation. It has been shown, for example, that intelligence quotients vary on the average from the highest for professional men to the lowest for unskilled workers. In other words, men engaged as editors, lawyers, college and high-school teachers, and diplomats have greater intelligence than those engaged as laborers, masons, shoemakers, sailors, etc. This seems to imply that the degree of intelligence possessed determines the chances of success in certain lines of work. It has been pointed out, however, that intelligence quotients should not be employed exclusively as a basis of vocational guidance. They should be supplemented with special aptitude tests which measure the specific traits demanded by the occupation or trade each individual may desire to enter. (9)

MECHANICAL APTITUDES TESTS. Most typical of all vocational aptitude tests, used to supplement intelligence tests in furnishing information regarding vocational fitness, is a type known as *mechanical aptitude tests*. These are constructed to reveal traits involved in the performance of tasks that require some degree of mechanical ability. Of these there are two types: (a) tests designed to discover general mechanical ability, and (b) tests designed to measure the specific capacities demanded by particular types of mechanical service.

Tests of general mechanical ability are intended to reveal symptoms of mechanical aptitude rather than specific aptitudes. One test of this type, for example, consists of a number of disassembled objects, such as a bicycle, a simple lock, and a mouse trap, which the subject is to assemble as accurately and as quickly as possible. The score on the test is the number of objects the subject can assemble and make in a given length of time. The score is taken as a symptom of mechanical ability because it indicates speed and accuracy of performance as well as the degree of insight and skill possessed by the subject. Another test of this type includes as test items pictures of different parts of mechanical devices which the subject is to mark in order to show their relationships. This kind of test measures the

amount of mechanical information possessed by the subject and also his tendencies to observe and conceive mechanical things. These traits are also taken as symptoms of mechanical ability. Such tests as these examples illustrate are used in the study of individual differences, as a basis for advising the choice of courses of instruction, and to some extent as a basis for vocational fitness. They would not be used, of course, as the sole basis for judging a person's fitness for special lines of mechanical work.

The second type of mechanical aptitude test mentioned above is designed to isolate and reveal the specific capacities and traits involved in particular kinds of mechanical work. The best test of this kind is an observation of an individual in the actual working situation. Since this type of observation is practically impossible, efforts have been made to devise a miniature lathe which duplicates the essential features of an actual lathe. The task of the subject is to follow a set of instructions regarding the operation of the miniature. Since the instructions are intended to induce performances similar to those involved in engine-lathe operation, the subject's score on the test is indicative of the specific aptitude being measured. Tests of this type have been used to select men for service as shopmen, chauffeurs, aviators, and various other trades. (5, 9)

Special Symptoms of Vocational Fitness. Not only are general and specific aptitude tests employed in discovering vocational fitness, but various other tests are employed to reveal symptoms of such fitness. These include numerous specific measuring devices previously described or suggested and various others that might be described. Preference is being given to the numerous specific tests described in the previous chapters and to the specific mental tests described above. Nearly all the traits for which specific measures have been devised are of interest to employment agents, the measures or scores of such tests being symptoms of fitness for any number of vocations.

The field of vocational aptitude testing is not limited to the tests already described. There are various other tests and rating scales for revealing aptitudes and tendencies considered essential in many vocations. These include measures of suspicion, disgust, honesty, temperament, neatness, conceit, sociability, likability, refinement, beauty, snobbishness, vulgarity, sense of humor, aggressiveness, deliberateness, and many others. Such

traits as these are usually evaluated by means of a rating scale, but they have also been studied by other means. Persons interested in selecting workers often make use of many types of test information.

Present Status of Aptitude Testing

In the early days of testing emphasis was placed upon the traits and measuring devices described in the previous chapter. Later those described in this chapter claimed the center of attention. At the present time interest appears to be centered chiefly in special aptitude testing. This interest is largely the outgrowth of the extensive use being made of such tests by large industrial concerns, many of which employ psychologists to construct and apply tests best suited to their needs.

Many colleges and universities are resorting to aptitude tests for the selection of students. This is particularly true of private colleges and universities which desire to limit their enrollments. Students desiring to enter these must "pass" a scholastic aptitude test and present various evidences of scholastic ability, such as a good high-school scholastic average. Many colleges and universities which do not limit their enrollments make use of aptitude test results in advising students in regard to passing and failing their work, in the choice of courses of instruction, and in the selection of vocations.

Though aptitude tests are used for these various purposes, they are never relied upon as the sole criterion for judging ability. Efforts are usually made to collect as much information about individuals as it is possible to secure. Important among the various types of information obtained are measures of personality traits, previous vocational and scholastic records, teachers' and employers' estimates and judgments, achievement, and interest.

Aptitude Tests Classified According to Form

Aptitude tests may be classified according to the manner in which the items are arranged and according to the kind of score it is desired to secure. Since this classification will reveal more clearly the nature of aptitude tests, it is helpful to study them from this standpoint. The different kinds of tests revealed by this classification are presented and described below.

Power Tests

A power test is intended to measure the limit of difficulty of tasks a subject is able to perform. The test items, or specific tests, are usually arranged in the order of increasing difficulty, that is, from the least to the most difficult. The subject's score is the number of test items that he can do correctly. Since the object of the test is to see how difficult are the tasks with which the subject can deal, there is usually no time limit set for completing it. Each subject is given all the time he needs. This type of test is based on the assumption that the more difficult the task a person can accomplish the greater is his mental ability and aptitude for particular types of tasks. (5)

Speed or Rate Tests

A speed or rate test is one in which the test items are all approximately equal in difficulty. No effort is made, at least, to arrange the items in the order of difficulty. The object of this type of test is to discover how quickly and accurately a subject can respond to the varied tasks included in it. The score, of course, is the number of test items correctly done in a given amount of time. This type of speed test is called the *work limit* type, and the score represents the amount of work accomplished in the time allowed.

Another type of the speed test is one on which the subject is expected to work as rapidly as possible until he completes a task or is told to stop. Here the score is the number of minutes or seconds required to do a specified amount of work. When this type of score is employed, the subject who has the highest score has done the worst, while the subject having the lowest score has done the best.

The assumption underlying either type of speed test is that a person who can work the most rapidly has the highest degree of mental ability. Since power and speed of performance are highly correlated, some power tests have a definite time limit. (5)

Cycle or Spiral Tests

The cycle or spiral test is a special type of the power test. That is, the exercises vary in difficulty, but they are arranged so

that the variations occur at regular intervals or cycles throughout the test. In a given test, for example, the 1st, 6th, 11th, 16th, etc., items or tests may be of one level of difficulty; the 2nd, 7th, 12th, 17th, etc., of another level; and the 3rd, 8th, 13th, 18th, etc., of still another level. That is, each level of difficulty appears in a regular cycle but in different parts of the test, and each successive item is more difficult than the one preceding it. The object of the test is to present the subject with both easy and difficult tasks, and thus to measure his ability to react to each. Usually, there is a time limit for the completion of each cycle. (7)

Scaled Test

This is a test in which the separate items are arranged in the order of increasing difficulty and the increase is constant from the beginning to the end. For example, the third item is as much more difficult than the second as the second is more difficult than the first, and the steps between successive items are equal. The least difficult items are sufficiently easy for the subjects to do them correctly, but the most difficult are too hard for the brightest subjects to do. The object of the test is to measure the complete range of each subject's aptitude.

EXERCISES

1. What is meant by anthropometric measurements? In schools not equipped for making such measurements, what substitute equipment is often used? What is the value of this substitute?
2. In what ways may the school make use of the data obtained in tests of physical traits?
3. How is it possible for the classroom teacher to make some progress toward the diagnosis of visual defects without especially prepared visual tests?
4. Indicate the signs by which the classroom teacher who lacks refined tests can partially diagnose auditory defects.
5. Which is usually considered more serious, defective vision or defective hearing? Why?
6. If the teacher learns of the existence of sensory defects in children, what should she do?
7. Distinguish clearly between *tests of specific motor capacities* and *motor ability tests.*
8. What uses can be made of the information obtained from the scores of motor ability tests?

9. Distinguish clearly between the two general types of tests used for measuring sensory capacities. Give examples of each type.
10. What is meant by a motor achievement test? Give examples of such a test. What use is made of the scores obtained from motor achievement tests?

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CHAPTER XX

EDUCATIONAL MEASUREMENT

INTRODUCTION

Purpose of the Chapter

Another division of the field of measurement, and one to which attention will be called in this chapter, is that known as *educational measurement*. This comprises the construction and application of tests for the purpose of evaluating the outcomes of organized training and instruction, particularly in the school subjects. In the discussion of the field, an effort will be made to describe various types of tests that are being used, and to indicate some of their merits and limitations. Even though our purpose is mainly that of acquainting students with different types of tests, some attention will be given to the manner in which they are constructed, administered, scored, and used.

Classification of Tests

Educational tests may be thought of as being divided into two general types: (a) teacher-made, and (b) standardized tests. Each of these types is designed mainly to measure *achievement*, or the degree of accomplishment, proficiency, or progress acquired by pupils in the mastery of anything being learned. The chief object of such measurement is that of securing scores, marks or grades by which the pupils' progress may be indicated to parents or others to whom they are responsible or to whom the teacher is responsible. Both types are subject to various sub-divisions, of course, which will be indicated in the discussion that follows.

TEACHER-MADE TESTS

Classification

For the purpose of the present discussion, teacher-made tests may be divided into two types: (a) subjective and (b) objective;

or *traditional* and *new type*. The latter designation is made by some writers in view of the fact that subjective tests were commonly used long before objective tests were devised. Although this is the case, the terms *subjective* and *objective* are commonly employed as names for the two types under consideration. Below is presented a brief discussion of the nature, merits, and uses of each type.

Subjective Tests

A subjective test or examination is one in which the teacher's opinion, feelings, attitude, personal bias or prejudice may enter into the evaluation of the pupil's achievement. A teacher may also be influenced by such factors as neatness, spelling, legibility of handwriting, and previous records of the pupil, as well as by her like or dislike of the pupil and by her moods, temperaments, and disposition at the time the estimate or evaluation is made. In other words, the scores on a subjective test are not open to verification by others and are often without precise discrimination.

Tests which appear to be subjective are of three main types: (a) personal estimate of the pupil's achievement, progress, or ability, (b) oral tests and examinations, and (c) written or essay tests or examinations. For many generations, these three types have been employed by teachers in arriving at marks or grades. It may be worth while to describe each of these methods of grading and to examine their merits and demerits.

Personal Estimate

DESCRIPTION. The *personal estimate* type of marking or grading is based upon the "impressions" made by the pupil upon the teacher. The impressions, in turn, are derived from the teacher's observation of the pupil's behavior and performance in and out of class. Some of the "standards" by which the teacher arrives at the grade are doubtless the pupil's apparent quickness or aptness to learn, the interest and attitude that he appears to assume regarding the work, the pupil's "application" or diligence in preparing assignments, the readiness or frequency with which the pupil responds in class, and possibly many other more or less indefinite and vague bases of judgment. Whatever the standard, teachers usually assign marks to pupils

daily, weekly, or monthly, and report these or their averages to parents on report cards designed for the purpose. At the end of a term or year, these grades are used as a basis for promotion, retention, or demotion, according to the teacher's judgment of the pupil's achievements. Often only a very small margin has separated the lowest passing grade from a failing grade.

In some schools, grades are arrived at by the "conference method." This is a procedure in which several teachers get together and decide upon each pupil's grade, as well as whether he should pass or fail. Since there is likelihood of differences of opinion among teachers regarding many pupils, passes or failures may be determined by "majority rule."

ADVANTAGES AND DISADVANTAGES. While there are some advantages to be claimed for the personal estimate type of grading, there are also various disadvantages. The advantages consist in the fact that teachers who observe pupils closely are likely to get fairly accurate impressions of what they can and cannot do in a given subject. The teacher knows, for instance, whether a child writes or reads well, and whether he can solve problems in arithmetic. She knows, too, whether a given pupil is diligent or lazy, and whether he likes or dislikes a given subject. Through daily association, she knows many of the other strong and weak points in each pupil's performance. Thus, by generalizing her impressions, and having in mind some scale of grading, such as A to F, the careful teacher can assign a fairly accurate grade. At any rate, teachers' estimates are usually considered sufficiently accurate to use as one criterion by which to establish the reliability of other types of tests.

The disadvantages of personal estimates arise largely in connection with exceptional cases. When she has a large number of pupils to observe and grade, it is humanly impossible for a teacher to know every pupil's work well enough to be accurate. Consequently, she is likely to make gross errors in grading pupils, particularly those who are less talkative and self-assertive. Too, there are numerous opportunities for error in connection with the teacher's own feelings or attitude. Some teachers are known to be "hard" and others "easy" graders. Some estimates may be influenced by moods or temperaments at the time they are made. There may be pupils that the teacher particularly likes or dislikes. In all such cases, the teacher's

estimates may be unduly influenced. At any rate, teachers themselves admit that such factors often enter into their grading. Besides, as observed earlier, even unconscious attitudes may influence one's estimate of another's performance or value. Consequently, there is much to be said regarding the inaccuracies of the personal estimate type of grading.

Even though this method of grading has many disadvantages, it is used rather extensively in the primary grades. This probably is the case because pupils in those grades are rather difficult to test in any formal way. Many cannot write or read, and others are more or less unable to appreciate the fact that they are being tested and should do their best.

Oral Tests and Examinations

PROCEDURES. An oral test or examination may be conducted by one or more teachers and administered to pupils singly or in groups. The type of oral test most commonly employed is one in which a given teacher examines an entire class. In this examination the teacher usually has a set of questions prepared, all of which each pupil should be able to answer. She proceeds by presenting the questions orally and one at a time, designating a given pupil to answer each. While the pupil is answering a given question, the teacher is deciding upon the correctness and merit, often recording the grade or score as soon as the pupil has finished. The pupil's final grade or score is determined either by the number of questions he answers correctly or by the sum or average of the estimates given each answer, or by both.

Another procedure of oral testing consists in several teachers examining each pupil individually. The pupil is usually asked to sit or stand in a central position facing the examiners, while they ask him prepared questions. The pupil may be questioned by each examiner separately, and with questions coming from first one then the other. When the examination is completed, the examiners compile their judgments and decide whether the pupil has passed or failed.

This oral method of testing was at one time a very common practice among the schools, but it has gradually been reduced by the use of written and printed tests. It was a common practice when schools and classes were small, and only a few pupils

had to be examined. Because of larger classes and large numbers of pupils to be tested at the present time, the oral examination is infrequently used. It is still used, however, in the examination of candidates for the higher degrees, particularly the doctor's degree, and in the examination of individuals who cannot read and write, as in case of the blind and deaf.

ADVANTAGES AND DISADVANTAGES. The first type of oral test described above is obviously a poor method of examining pupils. In the first place, the pupils are usually unduly excited and nervous. In the second place, not all pupils are required to react audibly to all of the questions. Besides, a pupil may be called upon to answer the only question that he does not know. In the third place, the examiner is undertaking too much work at one time. It is impossible to keep up with the pupils who have and have not answered questions, and at the same time to score the responses accurately. Finally, the test consumes too much of the teacher's time.

The second type of procedure has many practical advantages. First, it forces the pupil to deal with questions and problems in a social situation that corresponds somewhat closely to the situations of everyday life. Such tests will train the pupil, therefore, to think quickly in the presence of others and to deal with questions as they arise. Second, the group oral examination gives the examiners an opportunity to judge a pupil's mental alertness, his quickness in recalling and using acquired skills and information, and his disposition to think logically. In other words, the oral test reveals a pupil's general method of attacking problems together with any gross errors that may appear in his thinking.

The disadvantages of the group oral examination are such as to discourage extensive use of it. For one thing, it requires the presence of several teachers for a single pupil. For another, it often creates a situation in which the pupil cannot do his best, a situation that tends to excite some pupils to the point of serious distraction.

Written Tests and Examination

NATURE. The third method of determining pupil achievement is by means of the *written examination*. By this is meant any type of examination in which the pupil is required to write

out answers or solutions to a limited number of questions or problems assumed to represent the materials covered in a given subject or unit. The most common test of this general type is the *essay test*, which consists of a number of more or less general questions for the pupil to answer or discuss in essay or continuous narrative. The questions usually require the pupil to recall and set down the most significant facts, trends, processes, events, principles, laws, etc., that he has been studying. What the student is to do is usually suggested in each question by many different terms such as "discuss," "explain and illustrate," "summarize," "give ten facts regarding," and many others. In attempting to answer questions of this kind, the pupil is expected to reveal many and varied products of learning, depending on the type of question. Some questions stimulate memory; others stress ability to recall and organize materials; others are intended to reveal insight and understanding; others emphasize ability to solve problems; and others call out items of general or specific information. A given examination may stress all of these and other products of instruction and learning. In any case, the essay type examination furnishes only a limited amount of stimulation, leaving the student to engage in active recall and reflective thinking.

USES. The written examination has long been regarded by educators as a fair test of achievement. It has been and is still being used extensively in nearly all courses of instruction. Even achievement in the acquisition of skill is frequently measured by this method by requiring the pupils to describe the nature of their performances. It has not been many years since most colleges admitted their students on the basis of results of written examinations. Many civil service examinations are of this kind. Examinations for licenses to practice law, medicine, dentistry, accounting, etc., are frequently of the essay type. In short, there is scarcely a field of learning or instruction in which the written examination is not used.

GRADING. The grading of written examinations is usually intrusted to persons who are well acquainted with the subject matter they are designed to cover. In school, they are most frequently graded by the teacher who makes out the questions. When given for special purposes, they are graded by "experts" in the separate fields. Some graders use a "model paper";

others base their estimates on "general impression"; others score each question separately, keeping count of the items given and missed and summing up the separate values; others stress "content" and minimize "form"; and others stress form and minimize content. In one way or another, after considering the merit of its contents, together with mistakes and omissions, a grader arrives at the value of the "paper," in terms of some scale, using most frequently an absolute percentage rating in which 100 per cent represents a perfect paper.

ADVANTAGES AND DISADVANTAGES. The advantages or merits of a written examination depend for one thing upon the nature of the different questions; that is, upon the purpose of each question, the way it is stated, and the type of answer the pupil is expected to give. The advantages also depend upon the general purpose of the examination. Assuming that a written examination is well constructed in every detail, and that it is designed to serve as a measure of pupil achievement, the following advantages have been claimed for it: (a) it provides an opportunity for the pupil to recall and organize his thoughts accurately and systematically; (b) it furnishes a basis for sustained and connected thinking; and (c) it enables the teacher to discover whether or not the pupil can express his thoughts clearly and in good English. Such advantages as these serve as standards for determining the degree of achievement a pupil has reached, teachers and experts assuming that a good pupil should be able to do the things suggested.

The disadvantages of the written examination appear to be more numerous than the advantages. First, from what has been said of grading, it is clear that written examinations are difficult to grade accurately. Since each grader may employ a different method and a different set of standards, it is highly improbable that any two graders will arrive at the same grade when both evaluate the same paper. Besides, as noted above, the grader may be influenced by any number of personal factors as well as by such factors as neatness and legibility of handwriting. These facts have been demonstrated by a number of investigations which reveal that under different circumstances the same teacher will give the same paper widely different grades, and that several graders usually disagree as to the value of a given paper. One investigation, for example, reveals the

following results obtained from 116 geometry teachers who graded a final examination in geometry: Two grades were above 90, twenty were above 80, twenty were below 60, and one below 30; and forty-seven teachers said the pupil should pass, sixty-nine that he should fail. Similar results have been obtained from studies of grading in the fields of history, geography, and English. It is obvious, therefore, that the grading of written examinations is highly inaccurate.

Other disadvantages of written examinations may be summarized as follows: (a) They cover only a limited range of subject matter. This is a disadvantage in that it is possible for a particular pupil not to know the answer to a single question and yet have a fairly comprehensive knowledge of a course. Another disadvantage is that pupils are constantly alert to discover what the teacher thinks is important or what she is likely to ask about. This disposition frequently results in partial mastery of a given field of subject matter. (b) Pupils often misunderstand or misinterpret particular questions, and give incorrect answers when they are capable of giving correct ones. (c) Because of the limited range of subject matter covered, there is often too great a penalty resulting from omissions and failures. In other words, the pupils may fail a course because of his inability to answer a given question when he could answer many others equally as important. (d) When the pupil knows that mistakes in English, lack of neatness, poor handwriting, incorrect form, and other similar factors will be penalized, he may give more attention to these matters than to the content of his answers. (e) Written examinations tend to over-emphasize the teacher's point of view rather than to place proper emphasis on the available information in the course. As suggested above, pupils are more likely to learn what the teacher stresses than they are to learn what they could be led to discover for themselves. (11)

Objective Tests

Because of the marked disadvantages of subjective methods of measuring achievement, many teachers are beginning to employ a variety of objective tests. These are tests in which the items are arranged so that they can be scored by means of a key or other set standard of correctness, and thus the score

will be the same when arrived at by different persons or by the same person at different times. In other words, objective tests are intended to obtain marks and grades that are relatively uninfluenced by the subjective factors mentioned above, and by such factors as neatness or lack of it, quality of handwriting, time of day, etc.

Though teacher-made objective tests are similar in form to the standardized tests described above, they usually consist of only one or a few of the specific types of test items illustrated. For this reason, they will be divided into the following types: (a) true-false, (b) multiple choice, (c) matching, (d) short answer, and (e) completion. An effort will be made to indicate how each of these may be constructed, administered, scored, and graded, and to reveal some of the advantages and disadvantages of each.

True-False Tests

CONSTRUCTION. The true-false test is usually made up of an equal number of true and false statements covering the material that the pupils have studied. The task of the pupil is that of reading each statement, deciding whether it is true or false, and indicating his decision by writing the word "true" or "false," or by placing such symbols as T and F or plus and minus for true and false, at the beginning or end of each statement, in an appropriate blank, or by encircling T or F found at the beginning or end of each statement. The following forms are convenient ones:

+1.__________ −1.__________
−2.__________ +2.__________
T (F) 1.__________

A variation of the true-false test is the "Yes-No" type. This consists of a series of questions each of which can be answered by yes or no or by a symbol of either.

Although the construction of a true-false test may appear relatively simple, it really requires considerable thought and care. The following suggestions often prove helpful: (a) Prepare a list of statements covering the portion of subject matter over which the pupils are to be examined, selecting the most vital or important facts or ideas that should be included. (b) Change

half of the true statements to false ones, being careful not to make the falsity too obvious. (c) Be certain to avoid long, ambiguous, trivial, or suggestive statements, making each statement a positive one if possible. (d) Avoid half truths or partly true and partly false statements, and especially compound sentences containing two separate ideas one of which is true and the other false. (e) Arrange true and false items in random or chance order. (f) See that the pupil's answers are dependent upon his knowledge of the subject matter rather than upon the form or position of the statements. Negative statements, for instance frequently suggest their own answer. Too frequently a given question answers one that precedes or follows. (g) In general, it is wise to avoid using statements containing "all," "never," "always," etc., for such terms usually suggest the correct answer to the bright pupil. (h) Use as many as one hundred statements or more, for shorter tests have proved unreliable, unless the true-false items are only one of several types of questions to be included. (3, 8, 9)

ADMINISTRATION. True-false tests may be administered in oral or written form. When presenting the test orally, the teacher should proceed somewhat as follows: (a) Supply the pupils with uniform strips or sheets of paper, when possible, and have them set down a column of consecutive numbers to represent the separate items. (b) Instruct the pupils how to indicate each answer, the symbol to use, and where to place it and whether to guess or not to guess. (c) Read each statement twice, slowly, clearly, and deliberately, and allow plenty of time between statements for the pupils to think out their answers. (d) Caution the pupils not to give an indication of the answers they are setting down, as their answers might influence the decisions of others. (e) Avoid voice changes or inflections, smiling, etc., which might suggest the correct answers.

When true-false tests are presented in written form, the procedure is somewhat as follows: (a) Provide each pupil with a mimeographed copy of the statements. (b) Call attention to the written directions, stressing those that might be overlooked. (c) Insist that each answer be clearly recorded so that there can be no doubt as to what the pupil means.

There has been considerable debate as to whether pupils should be instructed to guess or not to guess, especially before

a number of investigations were made to settle the question. The majority of the investigators reach the conclusion that it is better to instruct the pupils not to guess. Perhaps the best instructions to give are somewhat as follows: *Directions:* "Some of the following statements are true and some are false. Mark each true statement with a plus sign (+) on the dotted line (or in the parenthesis), and each false statement with a minus sign (−). Mark statements that you do not know with a 0. Do not guess. Ask no questions. Hand in your paper when you have finished." (3, 11)

SCORING AND GRADING. True-false tests may be scored in a variety of ways. On occasions, pupils may score their own or each other's papers. When this is done, the teacher reads the number of each statement and gives the correct symbol while the pupils mark those missed with an X and those omitted with a 0. This method is obviously subject to many errors.

If a high degree of accuracy is desired, true-false tests should be scored by a practiced grader by means of a scoring key. The key is made by marking each statement correctly on the same form as that marked by the pupils and then folding the sheet into a strip with the correct symbols near the edge. The grader lays this strip on each paper to be graded so that the lines or parentheses on it correspond to those on the paper and so that the correct symbols are seen adjacent to the pupil's symbols. The grader then marks the statements missed and omitted, leaving the correct answers unmarked. It is necessary to mark those missed with one symbol, as with a dash to the left, (——), and those omitted with another, as with a wavy line (∼∼∼).

A score for each pupil is obtained by subtracting twice the number missed plus the number omitted from the total number of statements or items in the test, which is equivalent to subtracting the number wrong from the number right. The score is obtained in this way to overcome the effect of guessing. It is possible for a pupil to get a considerable score on a true-false test when he is totally ignorant of the subject matter. He might do this, for instance, by marking all the statements true or all false, or by flipping a coin, getting at least half of the answers correct. By using the formula R-W, the resulting score would be zero or very near zero, as it should be.

USES AND ADVANTAGES. Though strictly objective, the true-false test is not the most reliable instrument for the measurement of achievement. This is true because specific answers may be arrived at by determiners other than actual knowledge of the subject matter. For one thing, there is a large chance factor. As indicated above, a pupil who is totally ignorant of the subject matter may make a considerable score. Though this factor is controlled to some extent by drastic scoring, the defect is impossible to remove. Another defect is the failure to discriminate between that which is well known and that which is only vaguely known by pupils. In other words, it is possible for a pupil to mark statements correctly, even though he is only vaguely aware of their truth or falsity. Because of a tendency to mark statements correctly when they are only vaguely known, a poor pupil is often able to make a score equal to that of a good pupil. Besides, some individuals are probably more able than others to utilize isolated items of knowledge or information and thus to make correct decisions more frequently. Still another defect in the true-false test is its tendency to make many pupils feel that the questions are "tricky" or "catchy," and this feeling prompts them to overemphasize particular words or ideas in making a decision. Moreover, bright pupils often know much about a given statement, and thus mark it incorrectly because of their ability to regard it from standpoints the average pupil would never think about. Thus, the true-false tests too often penalize a considerable amount of thinking.

Because of these more or less apparent objections to the true-false test, it should probably be used more as a teaching device than as a measuring instrument. The grades, at least, should be supplemented by others derived from other types of tests. When it is used as a teaching device, the true-false test is valuable in helping to concentrate the attention of pupils on significant facts and in helping to train them to think accurately concerning many problems. The flexibility of the true-false test enables the examiner not only to cover a large amount of material but also to emphasize many points that the pupils might otherwise overlook. Not everything the pupil should know or be able to do can be tested by true-false statements or yes-no questions, of course, but a relatively large amount of information can be included. In making true-false tests and in studying

the mistakes made, when the papers are returned and discussed, pupils are acquainted with many new points of view and ways of stating facts or untruths. Thus the use of the true-false test may be strongly recommended because of these values in addition to the measuring values. (3, 8, 9)

Multiple Choice Tests

VARIETIES. Multiple choice tests consist of test items which are to be answered by choosing a correct answer from among several possible answers. There are two variations of this type. In one, the items contain several possible answers only one of which is correct. Examples of such items are the following:

( ) Electricity is conducted by (1) wood, (2) asbestos, (3) rubber, (4) copper, (5) glass.

( ) America was discovered by (1) Amerigo Vespucci, (2) Columbus, (3) Washington, (4) Lincoln.

This kind is known as the *choice answer* type, in which the task of the pupil is to choose the correct answer, and place the number corresponding to his choice in the parenthesis to the left.

A second variety consists of items in which there are several answers either of which is correct but one is more suitable than the others. Examples are such as the following:

( ) Bricks are used for (1) money, (2) weights, (3) ornaments, (4) houses.

( ) Clothes are used for (1) ornaments, (2) protection, (3) comfort, (4) pleasure, (5) selling.

This variety is known as the *best answer* type. The task of the pupil in dealing with an item is that of choosing the best or most appropriate answer and placing the number corresponding to it in the parenthesis to the left. It is obvious that the best answer type of item is both difficult to formulate and to answer, and that it is a kind of item which can be made to require an exact knowledge and a high degree of discrimination.

CONSTRUCTION. In order to construct a good multiple choice test, it is necessary to be very cautious in formulating each item. No one of the choices, for instance, should be too obviously incorrect; if it is, the measuring value is approximately nothing. It is wise, therefore, to choose incorrect answers that

are more or less closely related to the correct one. In general, four or more choices should be provided, because fewer than four permit chance factors to operate too largely in selecting an answer. The correct answers in consecutive items should be given different positions and numbers, although no set order which could be discovered by the pupil should be employed. Like the true-false test, the multiple choice should contain at least one hundred items.

ADMINISTRATION. The multiple choice test may be given orally or in written form. If given orally, especially to young children, the possible answers should be mimeographed and placed in the hands of the pupils to mark, the teacher reading each statement as in giving a true-false test. When the possible answers are single words or short expressions, the entire test may be presented orally. In giving the multiple choice test, the teacher proceeds in the same manner as giving a true-false test, using directions such as the following: "Place in the parenthesis to the left of each statement the number of the best or most appropriate answer provided. Only one number should be used. Answer all questions, guessing when you are not certain of the correct answer." Guessing is encouraged in taking the multiple choice type because the chance factors are reduced to a minimum.

ADVANTAGES AND DISADVANTAGES. When it is constructed correctly, the multiple choice test is one of the most reliable types of measuring instruments. It not only eliminates many of the chance factors that operate in the true-false test, but it tends to compel the pupil to make accurate and discriminative decisions. It is of greatest value, perhaps, in measuring achievement in school subjects containing a considerable number of specific facts to be learned, although it can be used in testing the pupil's understanding of many types of relationships. It is a valuable teaching device, especially when pupils are asked to explain why they chose incorrect instead of correct answers. Such a procedure, at least, enables the teacher to discover the weaknesses in pupils' thinking and to reveal to them how to make accurate decisions in regard to materials that are closely related.

The chief disadvantage of the multiple choice test is its failure to emphasize active recall and organization of materials

that have been learned. It is also limited largely to factual material and to relationships, and it is relatively difficult to construct. Nevertheless, its widespread use in standardized tests is sufficient to emphasize its applicability to testing conditions in most school subjects. (3, 9, 11)

The Matching Test

CONSTRUCTION. The matching test consists of two separate groups of items that are related in some prescribed manner, and which the pupil is called upon to match or identify as being related. Typically, a matching test is constructed by placing one group of items in a column to the left and the other group in a column to the right on the page, with consecutive numbers at the left of one group and blanks or parentheses at the left of the other. The task of the pupil is that of placing the number in the proper blank or parenthesis. Following is an example:

1. 1775	( ) Texas admitted to the Union
2. 1492	( ) Jamestown settled
3. 1802	( ) Washington inaugurated
4. 1845	( ) America discovered
5. 1607	( ) Ohio admitted to Union

The separate columns may be single items, such as dates, short expressions, or complete sentences, according to the desire of the examiner. The effects of guessing are greatly reduced if the second column contains several items that correspond with none of the numbered items.

A variation of the matching type of test is illustrated below:

(1) Sensory, (2) motor, (3) association, (4) interconnecting neurons:

( ) extend from the spinal cord to the reactors
( ) conduct nervous energy from receptors to the central nervous system
( ) are found in the cortex
( ) relay nervous energy from lower to higher levels of the nervous system
( ) conduct nervous energy from one neuron to another
( ) are totally afferent in function
( ) are totally efferent in function

Here the task of the pupil is to select a heading that is described or illustrated by each of the statements, and to place

in the proper parenthesis the number of that heading. The number of headings may be as many as ten or twelve and the statements as many as are desired, for several statements may be employed in describing or illustrating any one heading. In general, the headings should be things that are related to each other and that the pupil should be able to distinguish, in which case the measuring becomes highly discriminative.

ADMINISTRATION. In administering the matching type of test, the teacher proceeds very much as in giving other types of tests. She should make clear what the pupil is to do and whether he is expected to place a number in each of the blanks. If a high degree of discrimination is expected, she may include statements that are not to be marked, but she should tell the pupils that such statements are contained in the test, indicating whether there are few or many. Otherwise, the pupils may become greatly confused.

SCORING. The matching test is scored with a key in the same manner as the true-false and multiple choice types.

ADVANTAGES AND DISADVANTAGES. The matching test is an excellent type not only as a measuring but also as a teaching device. When it is constructed correctly, the guessing factor is almost eliminated. The pupils are forced to make accurate discriminations and to regard facts and terms in various relationships and from different points of view. Thus a study of pupils' errors will reveal not merely the pupils' lack of knowledge but also their inability to think accurately. In other words, use of the matching test will encourage studying for the purpose of knowing and understanding, and will discourage memorizing for the sake of recalling items that are not understood. By making headings of significant terms or ideas, the teacher can reveal to the pupils the organization of the subject matter and the things they should know most about. Thus the matching type of test is an excellent instrument by which to review different sections of the course, for it can be used to cover an entire course.

The disadvantages of the matching test are about the same as those of the multiple choice type. In addition, the matching test is rather difficult to take, especially by pupils who are not thoroughly familiar with the subject matter. Many pupils complain of becoming confused when they attempt to take

these tests, especially the second type of matching test indicated above. Nevertheless, frequent use of this type is to be commended. (11)

Short-Answer Test

Construction and Administration. This type of test is constructed by setting down a series of questions each of which can be answered by a single word, phrase, or short sentence. Such questions as the following are examples:

Who discovered America? _______
Of what state is Austin the capital? _______

Usually such a test is mimeographed with instructions to the pupils to fill in the blanks with correct answers. When it is presented in this form the pupil writes his answer on the mimeographed sheet. This type of test, however, may be presented orally by the teacher. In this case, a pupil is instructed to set down consecutive numbers, and to place by each number his answer to the question the teacher asks. If the answer is not known, the pupil should be instructed to leave the space blank or to put an X by the number. Care should be exercised in selecting questions that can be answered uniformly. Otherwise, the scoring becomes tedious.

Scoring. If questions are used to each of which there is only one or two possible answers, the scoring of short-answer tests can be done by a key. The score is usually the number of correct answers, although any question may be valued as much as is desirable. When questions are deemed unequal in value, the value of each question should be indicated in the key and written on the pupil's paper by the side of his answer. The score is the sum of the values assigned.

Advantages and Disadvantages. The short-answer type test emphasizes definite knowledge and active recall. The guessing factor is practically eliminated. For these reasons, it is a highly reliable test for measuring knowledge of specific facts, especially when the questions are properly formulated. It is also relatively easy to construct and administer. Although relatively objective, the short-answer type test is more difficult to score than are other objective tests. As a rule, each answer has to be inspected and judged independently of the key.

There is little teaching value in a short-answer test except that it helps pupils to master specific items of information. In other words, this type often fails to emphasize relations and organization of materials. (3)

Completion Tests

CONSTRUCTION AND ADMINISTRATION. A completion test is made up of sentences containing blanks in which the pupil must place significant words that have been omitted. In preparing a test of this type, the teacher usually writes out or selects complete sentences from a textbook, and then marks out one or more significant words in each. The incomplete sentences are presented to the pupils who fill in the blanks with the appropriate word or words. The following samples illustrate the type of sentence usually employed.

Columbus discovered ________ in ________.
Water is made of two elements, ________ and ________.

In constructing tests of this type considerable care must be exercised not to make sentences which contain blanks that are too indefinite. Note the following sentence: The weight of a ________ is measured by a ________. If a pupil attempts to fill in the blanks, he may select a number of different words for each. A test made up of sentences of this type could cause the pupils to guess at what the teacher wanted, and the teacher to give credit for answers that had little measurement value. Care must also be exercised in making sentences complete enough that the correct word gives it definite meaning. Completion type tests should be employed in testing material that the pupils should know very well. Because of the difficulty of keeping a great many ideas in mind at one time, it is usually unwise to present a completion test orally. In general, pupils should be supplied with mimeographed copies and instructed to fill in the blanks with the proper words.

SCORING. When a completion test is properly constructed, it can be scored by a key, which is merely a test properly filled out. Nevertheless, the grader should inspect each word inserted by the pupil to see if it makes a proper answer, and give credit to pupils who supply such words. This type of scoring

is necessary because of the difficulty involved in composing every sentence so that it contains blanks which can be filled with only one word.

ADVANTAGES AND DISADVANTAGES. The completion type test, like the short-answer type test, is usually considered highly accurate. If carefully constructed, it eliminates guessing and stresses accurate recall. Pupils who do not have a thorough knowledge of the materials find considerable difficulty in selecting appropriate words. It has the disadvantage, however, of being difficult to construct, and its use is limited to materials that have been thoroughly mastered. (11)

Mixed Types

DESCRIPTION. Perhaps the most satisfactory type of teacher-made test to employ in any school subject is a *mixed type.* This type contains several kinds of questions designed to test various aspects of pupil mastery. A typical mixed test or examination includes some true-false statements and yes-no questions, a number of choice answer type items, one or more sets of items to be matched, and a number of short-answer and completion types, with material represented in view of the type of mastery it is desired to measure. By a careful selection and formulation of test items, such a test might conceivably utilize all of the advantages and eliminate the disadvantages of each of the types discussed above. The teacher, therefore, has the opportunity of constructing a test that will measure a variety of abilities in pupils.

ADVANTAGES AND DISADVANTAGES. The advantages and disadvantages of the mixed type of test are the same as those of objective tests in general. The advantages are: (a) In objective tests, the responses of the pupils are controlled and recorded in definite and uniform ways, so that there can be no doubt as to the correctness or incorrectness of the scores. (b) They can be made comprehensive enough to cover almost every item of information pupils have been taught and are expected to know. By requiring the pupil to do only a little writing, he is free to devote his time to a study of the items. Thus, he can answer a large number of questions in a relatively short period of time. In this respect, objective tests are much superior to the essay type. (c) Objective tests can be used as teaching devices. After

the papers are scored, tests may be returned, discussed, compared, corrected, and studied. The pupils readily discover the weaknesses in their thinking as well as the points at which additional study is needed. They may also discover several new points of view in material that they have studied from only one point of view. (d) In general, most pupils favor the objective type test to the essay type. Although they often complain of becoming confused, they find that taking the objective type is less fatiguing. They also realize that the grading is impartial and fair, there being no opportunities for the teacher to show favoritism or bias. In other words, the fairness of the grading is unquestioned. This is also a distinct advantage to the teacher. (e) Teachers find objective tests desirable because they are easy to score. Because of this fact, teachers save much time and labor, and they are often more satisfied with the marks assigned than they are with personal judgments or estimates either of a pupil or a paper.

While these are distinct advantages, there are also various disadvantages and limitations of objective tests. These may be summarized as follows: (a) They are relatively difficult to construct, requiring considerably more time and thought than do essay tests. (b) They do not permit the pupil to reveal his ability to organize thought. (c) While various types of questions require fine discrimination and emphasize various relationships, the test as a whole does not emphasize the making of comparisons, giving explanations, and formulating definitions. (d) Rarely can pupils be asked to summarize material, to illustrate and apply principles, or to solve problems. They are more or less limited to dealing with what is set down in the test rather than dealing with what can be recalled and used.

For these reasons, objective tests should be supplemented at intervals by other measures. The teacher's judgment, when she is definitely acquainted with individual pupils, is a valuable index to each pupil's achievement. Grades on essay examinations are valuable contributions to the total score, for the reason that they emphasize abilities that cannot be conveniently measured objectively. Thus there are sufficient reasons for continuing the use of subjective tests and for supplementing these with other types where there is need. (8, 11)

Translating Objective Test Scores into Grades

One of the chief problems confronting a teacher, after arriving at the scores made by pupils on an objective test, is that of translating the scores into letter or percentage grades. By "grades" in this sense is meant marks which describe the achievement of an individual in terms of an absolute scale. In most schools, the achievement of pupils is represented by a percentage scale, on which 100 per cent represents perfect achievement and 60 per cent "passing." This scale is usually divided into six grade ranges designated by the first six letters of the alphabet, as follows: A = 90 to 100, B = 80 to 89, C = 70 to 79, D = 60 to 69, E = 50 to 59, F = 0 to 49. Other designations, such as excellent, very good, good, fair, poor, and very poor, are also frequently used. Whatever the means used to designate the grade of an individual pupil, 60 per cent is usually regarded as passing, 50 to 59 per cent as near failure or conditioned, and below 50 per cent as failure. Since some such scale is generally employed, the teacher must translate all test scores into grades.

This would not be a difficult problem were all tests perfect measuring instruments. If they were, the teacher could let the total number of test items equal 100 per cent and calculate each individual's grade by finding the percentage of correct responses. In many instances, however, tests are either too easy or too difficult, in which case nearly all pupils make A's or nearly all of them fail. Thus, in order to allow for imperfections in tests, the teacher must use some other means of calculating the grades, a few of which may be mentioned.

One way of calculating grades is to let the highest score made on a test equal 100 per cent, and then find all other grades by simple proportion. In order to do this, multiply each score by 100 and divide the product by the highest score. In employing this method, the teacher assumes that the pupil who makes the highest score on a test merits a perfect grade, regardless of the number of test items he has missed. She may assume further, that the items missed were either too difficult or that they were imperfectly formulated or arranged. The failing pupil on this basis is one who is unable to do as many as 60 per cent of the items done by the best pupil. In a normal class, the grades

derived by this method usually distribute themselves around 75 per cent or C on an average.

Another method of translating test scores into grades involves an arbitrary assumption of the per cent of pupils that are to receive various grades. The following ranges of percentages are suggestive: 5 to 10 per cent A, 20 to 30 per cent B, 35 to 40 per cent C, 20 to 30 per cent D, and 5 to 10 per cent E and F. The actual number of pupils assigned particular grades should be based on a study of the scores and the general practice of the school. A study of the scores can be made by first arranging them in order from highest to lowest. The teacher can then decide where the division points should be made and mark off the areas that should receive A's, B's, etc. The division points should be approximately the same distance apart in terms of the number of points on the test. By using this method the passing score is chosen arbitrarily, after a consideration of the total range of the scores and the apparent ease or difficulty of the test. By letting the passing score equal 60 per cent, and the highest score 100 per cent, it is relatively easy to assign a percentage grade to each of the intervening scores, as well as scores below passing. This can be done by setting down by the test scores arranged in descending order a column of consecutive numbers from 100 to 1, to represent a percentage scale, and matching the division points on the first scale, with 90, 80, 70, 60, 50, 40, etc., on the percentage scale. All intervening scores can then be assigned intervening percentage grades according to their positions.

The most accurate method of converting test scores into corresponding grades is to calculate the standard deviation of the distribution of test scores, and divide the total scale into intervals of one standard deviation. The chief reason for using the standard deviation is that this measure divides the scale into equal units on each side of the mean. Five such units, (two and one-half on each side of the mean), will include approximately 98.76 per cent of the cases; and six such units, (three on each side of the mean), will include approximately 99.73 per cent of the cases. The above percentages are true when the distribution is normal. When the scale is divided into five equal units, each of which may represent a grade range, we have the following:

A above $+ 1.5\sigma$
B from $+ 0.5\sigma$ to $+ 1.5\sigma$
C from -0.5σ to $+ 0.5\sigma$
D from -1.5σ to -0.5σ
E below -1.5σ

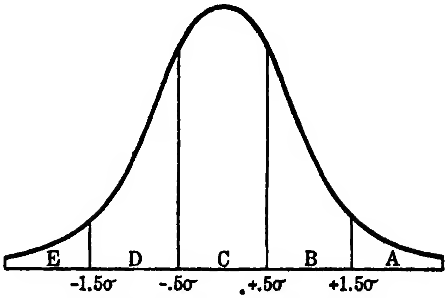

FIG. 34. Showing normal distribution curve divided into five sigmas.

These divisions are shown graphically in Fig. 34.

Sigma units are turned into score units as follows: (a) Find the mean. (b) Find the standard deviation. (c) Multiply sigma by each division point on the scale, as $0.5 \times \sigma$ and $1.5 \times \sigma$. Subtract each product from the mean to get the score which represents each point. The limits of the marks are then represented by score units. (11)

The methods of calculating the mean and standard deviation are explained in the next chapter.

STANDARDIZED EDUCATIONAL TESTS

Basic Principles of Construction

Although teachers have made considerable improvements in their methods of measuring achievement, particularly through the use of objective tests, there are many limitations to their methods that have to be made up through the use of *standardized educational tests*. These, it may be recalled, consist of a great number and variety of tests and scales designed, constructed, and released to the educational public by experts in the field of measurement. From the standpoint of the expert, a good examination must possess a number of characteristics which the teacher-made test may or may not possess; and these characteristics become the basic principles underlying the construction of each test. A discussion of these principles will reveal the nature and usefulness of standardized tests.

Validity

Just as it is important to know that an intelligence test measures general mental ability, it is equally as important to know

that a test of reading, or of any other acquired ability, measures that and nothing else. A few years ago an arithmetic test was administered to pupils in a certain grade in an Eastern school; and the problems were so easy that the pupils could solve them more rapidly than they could write their solutions and answers. Such a test is not a valid arithmetic test but rather a test of speed of writing arithmetical symbols. In order to be valid, a test must (a) include only those items that are important, (b) be in harmony with recognized teaching aims, and (c) get results comparable with other measures that are known to measure the same trait. Furthermore, the validity of a test should be fully established before it is offered to the educational public. These are characteristics which a teacher-made test may or may not possess, and which are made the definite aims or goals of the expert.

Validity is achieved by the expert by following certain principles of scientific construction and by subjecting the results of his test to a number of comparisons.

In constructing an achievement test, the expert proceeds somewhat as follows: (a) He determines the essential materials that pupils in a given subject should know. He does this in a variety of ways, a few of which may be suggested: By studying many textbooks dealing with the material; by consulting teachers of the subject in schools and colleges; by examining questions in college entrance examinations; by securing the opinions and judgments of interested persons in industry, business, and the professions; and by studying the general and specific aims of the subject, which educators are seeking to attain. By one method or another, the test maker determines the material that is important enough to be included in a test. (b) When he has determined the information that pupils in a given class or grade should have after completing a subject, the test maker prepares a trial form of the test and the directions for the pupils and the examiner. This trial form includes many items that will not appear in the final form, because some may be found unsuitable. The trial form may then be submitted to a number of expert judges or teachers, with instructions to underscore items which appear to be unsuitable, either from the standpoint of teaching aims, of content, or of form. By doing this, he is able to eliminate many items, and to reconstruct those that

appear to the judges to be faulty. (c) When the trial form is ready, the test maker tries it out on a large number of pupils in the grades for which it is designed, and thus he collects a body of data for further revision. On the basis of such data, at least, he can revise the directions, eliminate problems that are too easy or too difficult, determine time limits for parts and the test as a whole, arrange the questions in the order of increasing difficulty, etc. (d) When he has tried out and revised a test until it conforms to the requirements of scientific construction, the test maker tests its validity further by comparing its results with those of other measures of the same trait. In order to make comparisons, he gives his test to a large number of pupils and then secures a number of other measures from the same pupils. The other measures may include scores or grades on teacher-made subjective and objective tests, teachers' estimates of pupils, and the scores on other similar standardized tests. Comparisons are usually made by calculating the coefficient of correlation between each set of scores and the scores obtained by the new test. If the correlation is .90 or above, the validity of the test is assumed to be well established. The new test is then submitted to the educational public with a *manual of directions* for administering, scoring, and grading, in which is set forth a description of how the validity of the test was established. (6, 10, 14)

Reliability

A second characteristic of a good achievement test, which becomes a working principle and goal of the test maker, is suggested by the term *reliability*. This is the extent or degree to which a test measures that which it is designed to measure at a particular stage in learning. In the past, school authorities have had to depend upon such indices of achievement as the number of pages covered in a textbook, length of school terms, average daily attendance, and teachers' estimates and grades. Because he knows the limitations of such scores, the expert not only proposes a valid test but one that will secure an accurate score for each pupil. He does this by keeping in mind the following known facts: (a) that long tests are usually more reliable than short ones; (b) that objective tests are more accurate than subjective ones; (c) that any test must be given

under conditions favorable to the pupils; (d) that a measuring instrument should be consistent with itself, that is, any part of the test should measure with the same degree of accuracy as another part; and (e) that a measuring device should give the same results upon successive applications, particularly when the thing measured has remained unchanged. In view of such requirements, it is probably impossible to devise an accurate measure of achievement, but the standardized achievement test is generally considered the most accurate instrument for this purpose. The reason why it is so considered is that the expert test maker takes various steps which tend to insure the reliability of his instrument.

Steps for increasing the reliability of standardized achievement tests are usually as follows: (a) The test maker constructs a test that is long enough to include essential materials in a course. In order to do this, he includes relatively short items and presents them in a form that makes for ease and speed in dealing with them. For instance, the pupil answers the questions by making marks or symbols or writing down numbers, single words, or short expressions. No excess time is consumed by the pupil, such as might be involved in writing out long discussions. (b) The test maker employs the objective type of test item, choosing the true-false, multiple choice, completions, etc., types according to the nature of the material, eliminating the guessing factor, and making the answers definitely right or wrong. (c) He prescribes the conditions under which the test is to be given, cautioning others who might give the test to consider the time of day, noises or other interruptions, physical defects or conditions, temperature, lighting, seating, etc., and he insists that each examiner follow the directions implicitly and explicitly. (d) In order to establish the self-consistency of a test, the test maker usually determines the degree of correlation between the odd and even numbered items. In other words, he gives each pupil two scores on the test, one consisting of the number of odd numbered items answered correctly and the other consisting of the number of even items answered correctly. A high degree of correspondence between the two scores among a large number of pupils is indicative of a high degree of reliability. Usually the test maker calculates the coefficient of correlation and thus reveals the degree of

reliability. (e) A fifth method of insuring reliability of a test is to construct equivalent forms of the same test and find the degree of correspondence between the scores on the different forms. If two tests of the same trait yield equal scores in a large number of instances, the scores may be assumed to be reliable. (f) Still another method of establishing the reliability of a test is that of giving it a second time to the same pupils and comparing the scores made with each other. This would be the most reliable method of all were it not for the fact that the pupils do not remain unchanged. There is usually a practice effect carried over from one application to the other, due to the familiarity of the pupils with the test. When the amount of this effect is known from various applications of the test, and this amount is subtracted from each score obtained from the second application, the method can be used as a measure of the reliability of the test. As a matter of fact, the method is frequently used. Even when the practice effect is not known, each pupil should maintain his or her rank on the test in a second application. Thus, the two sets of scores may be correlated to show the degree of reliability. (2, 6, 12)

Norms, Ages, and Quotients

Another principle underlying the development of a standardized achievement test is that any score should have a definite meaning and standard value. This is not true of scores obtained from teacher-made tests. The values of particular scores on the latter depend upon translating them into a percentage or grade scale which proves to be as flexible or variable as the scores themselves. The scores from standardized tests, on the other hand, are evaluated by reference to a table of norms made up of the averages of pupils of different ages or grades taken as an adequate sampling of the total age or grade population. Thus, in order to find the value of a score made by a given pupil, it is only necessary to find the score in the table and look for the age or grade corresponding to it, and to compare this age or grade with that of the pupil making the score. When this is done, the teacher can determine whether the pupil's achievement is at, above, or below a particular age or grade level. Thus a score is evaluated in terms of the performances of representative pupils at particular ages or grades.

In other words, just as a table of norms for a group intelligence test enables a teacher to determine the mental age of a given pupil, a table of norms for an educational or achievement test enables her to determine the educational age (E.A.) or achievement age (A.A.) of a given pupil. For example, suppose that a twelve-year-old pupil makes a score of 30 on a given test. The teacher refers to the table of norms, and finds that this score is the average made by pupils of age 11 instead of 12. She knows then that the twelve-year-old pupil has an educational age of eleven, which is one year below normal. She may regard the pupil, therefore, as being retarded in his educational work. If a table of grade norms for the test is available, and one usually is, the pupil's grade status may be determined in a similar manner, which enables the teacher to know whether the pupil is at, above, or below his grade level.

Sometimes a teacher may make use of several tests on different subjects, and thus obtain several E.A.'s. In order to distinguish between these, it is customary to give each the name of the subject from which it is derived. Thus a pupil may be assigned a reading age (R.A.), an arithmetic age (A.A.), a spelling age (S.A.), and so on for each subject, each of which represents his standing in regard to the norms for that subject. Consequently, there are many educational or *subject ages*. Most frequently, however, *educational age* is used to refer to an average of the subject ages, and more particularly to the age level represented in a table of norms derived from a single test containing representative items from each of several subjects.

The educational age is a convenient device for making comparisons among children in the elementary grades, but it is not a good index of the achievement of individuals in the high-school grades. This difference appears in view of the fact that high-school pupils are a highly selected group. Many pupils found in the elementary grades drop out of school before reaching high school, usually because of failures or inability to do high-school work. Consequently, it is very difficult to find an adequate sampling of high-school pupils on which to establish norms for their ages.

Not only is it possible to find the E.A. or S.A. of a pupil from a table of norms, but it is also possible to find the educa-

tional quotient (E.Q.). This is found in a manner similar to finding the I.Q.; that is, by dividing the E.A. by the C.A. The E.Q., therefore, is similar in meaning to I.Q., except that it designates standing in achievement rather than standing in intelligence. Thus, an E.Q. of 100 is normal for a given age; and an E.Q. of 130 is above, while one of 70 is below. The E.Q. indicates, of course, whether a given pupil is doing superior, average, or inferior work in his studies or a particular study, just as the I.Q. indicates whether he is bright, normal, or dull. The E.Q. does not indicate, of course, why the pupil is at a given level. An E.Q. of 60, for instance, reveals that the pupil is doing very inferior work, but it does not reveal whether this inferior work is due to dullness, inferior instruction, lack of opportunity to study, or some other fact. In order to determine what causes a low E.Q., therefore, the teacher needs to take many other measures into account. It is highly important, at least, to study the E.Q. in connection with the I.Q., or the E.A. in connection with the M.A. Such a study will reveal whether the achievement of the pupil is a product of his mental ability. As a matter of fact, achievement test scores in general have little meaning to teachers except when they are studied in relation to other scores, particularly intelligence or special aptitude scores. For the sake of ease in making this type of comparison, the accomplishment quotient (A.Q.) is frequently used. This is obtained by dividing the E.Q. by the I.Q., which figure indicates whether a pupil is doing as well in a subject as his mental ability would seem to warrant. Here, again, of course, the normal is 100. But in spite of this recognized limitation, the scores obtained by standardized tests have far more significance and meaning than those obtained from non-standardized teacher-made tests.

There are several other types of scores derived from educational tests which will not be discussed in this text. A discussion of these may be found in many textbooks dealing more extensively with the subject of measurement.

Standardized test scores are usually translated into letter or percentage grades in much the same manner as teacher-made test scores. The method most commonly used is that of calculating the standard deviation for a group of scores and letting the limits of this unit represent the limits of the percentage

units. When this method is employed the mean score of a group is made equal to 75 per cent. (7, 11)

Types of Standardized Educational Tests

Standardized achievement tests have been constructed to measure nearly every product of training or instruction and many phases of various products. For this reason, they may be classified from a number of different points of view. Following are a few of the classifications:

I. Tests classified according to the purpose:
   A. Placement or Entrance Examinations.
   B. Inventory or Pretests.
   C. Diagnostic Tests.
   D. Practice or Instructional Tests.
   E. Survey Tests.
   F. Omnibus Tests.

II. Tests classified according to the aspect of achievement measures:
   A. Speed or Rate Tests.
   B. Power or Difficulty Tests.
   C. Quality Tests.
   D. Mixed Tests (varied aspect).

III. Tests classified according to type of products measured:
   A. Tests of Motor Skills.
   B. Athletic Tests.
   C. Information Tests.
   D. Character Tests.

IV. Tests classified according to grade levels:
   A. Preschool Tests.
   B. Kindergarten and Primary Tests.
   C. Intermediate Tests.
   D. High-School Tests.
   E. College Tests.
   F. Classification Tests.

V. Tests classified according to school subjects:
   A. Arithmetic Tests.
   B. Reading Tests.
   C. Handwriting Tests.
   D. Language Tests.
   E. History Tests.
   F. Geography Tests.
   G. Science Tests.
   H. Mathematics Tests.
   I. Etc.

From the outline, it is apparent that expert test makers have constructed tests for measuring almost every phase of education, which means there are literally thousands of tests on the market available and essentially ready for use.

It would require several volumes, perhaps, to present a complete description of each of the different types suggested. About all we can do here is to suggest the implication of the classifications.

Purpose Types

The first classification presented above suggests the many purposes for which tests are available. By making a proper selection, the teacher can select tests for such purposes as the following:

PLACEMENT. Placement tests are for the purpose of enabling the teacher to secure information about pupils which will enable her to assign them to proper grades. These are particularly useful in dealing with new pupils who appear as transfers from other schools and about which little is known. Such tests tend to reveal the abilities of pupils to do the work in a given subject or grade. These are usually given in connection with intelligence tests.

PRETESTING. Pretests are given by many teachers at the beginning of a course of study for the purpose of discovering the initial skill or information possessed by the pupils. By doing this, the teacher is able to discover individual differences at the outset. She also has some basis of predicting probable success or failure and for determining the degree of progress. Sometimes a pretest is the same as the final test in a given course, being very useful as a measure of the actual rather than the relative progress made by each pupil, especially when the initial and final scores are compared.

DIAGNOSIS. Diagnostic tests are constructed and given to discover special difficulties in various subjects. They are usually based on special parts of a subject which involves special abilities and skills. These tests have been developed most extensively in such subjects as arithmetic, algebra, and reading, in which some elements may be learned thoroughly and others poorly. A pupil may be very efficient in addition, for example, and very inefficient in multiplication. Diagnostic tests are designed to reveal such efficiencies and inefficiencies.

Practice or Drill Tests

Practice or drill tests usually contain many items of the same type and kind, on which pupils are to work for the purpose of perfecting their skill in dealing with various educational situations. Since there must be a considerable amount of drill in many subjects, these tests are developed to provide a means of standardizing drill and for measuring its effects. Some drill tests are given for the purpose of developing speed; others are given to bring about gains in power and accuracy.

SURVEY TESTS. Survey tests, as suggested above in the discussion of norms, are usually divided into several parts containing items covering the essential elements of each of several subjects. They are given for the purpose of indicating the relative performance of individuals, classes, schools, or school systems. Although each part may carry a different set of norms so as to determine the standing of each pupil or class in a given subject, there are general norms for the test as a whole.

OMNIBUS TESTS. The omnibus test is a kind of survey test, except that it contains items designed to measure abilities other than achievement. It usually contains a group of items for measuring intelligence, or a special aptitude, and may furnish devices for discovering visual defects. Thus the omnibus test is a kind of all-purpose test designed for schools that cannot buy or take time to use a series of separate tests. Although helpful in solving many school problems, this is not a very adequate measure of any one trait.

Aspects of Achievement

The different aspects of achievement which tests have been specially designed to measure include speed, power, and quality. It may be recalled that aptitude tests likewise exhibit these same types. Each type is briefly described below.

SPEED TESTS. A speed test emphasizes either the amount accomplished in a given time or the rate at which particular things can be done. A test of arithmetic, for example, reveals the number of arithmetic problems or examples a pupil can do in a given length of time, or the time required to complete a given set of operations. A speed test in reading, on the other hand, will reveal the number of words per minute each pupil

can read. Speed tests are emphasized mainly in writing, typing, arithmetic, and reading; but they may be constructed for any subject in which speed of performance is an important factor. In all such tests, the various items are similar to those in drill tests, and are usually of equal difficulty. (7)

POWER TESTS. Power tests as previously indicated are designed to reveal the degree of difficulty a pupil can attain, or the power or command he has over the subject matter in a given field. In these, there is usually a gradual increase in the difficulty of the items, the best tests having the items arranged in steps of relatively equal difficulty. These are usually employed in arithmetic, reading, language, and science. They are particularly helpful in diagnosing difficulties, and in determining the suitability of different types of materials for pupils in different grades.

QUALITY TESTS. A quality test is designed to determine how well pupils can do things, regardless of speed or difficulty. These are tests, for example, that assist in determining the quality of handwriting and of compositions. In these, the pupil is asked to write a given selection and his product is compared with examples of pre-established quality. Here there is more likelihood of errors in grading or scoring than in the case of any other type of objective test, as the grader has to compare each pupil's product with that of the standard provided.

MIXED TESTS. Many tests frequently measure several aspects of performance—speed, power, and quality. A test designed to measure quality of writing or reading may also stress the speed at which the performances are carried on. Nearly all power tests have a time limit. As a rule, the teacher should examine every test she uses with the view of ascertaining what trait or combination of traits it is expected to measure. Otherwise, gross errors in the interpretation of the results are sure to follow.

Tests of Educational Products

In a previous discussion of learning, an effort was made to suggest some of the products which may become the immediate goals of training or instruction. These were described as skills, knowledge, attitudes, etc. In many instances, test makers seem to have centered attention on these products and to have con-

structed tests for the specific purpose of measuring one or the other. Many tests, at least, may be classified from this standpoint.

Tests of Skill. Skill is considered expertness in doing a particular thing without error and with considerable ease and speed. Consequently, any quality or speed test could be used as a measure of progress in the acquisition of skill. Most tests of motor skill stress quality or form, accuracy, and speed; and progress is exhibited by constructing curves showing either an increase in form, quality, or accuracy, or the reduction of error, and a decrease in time. Composite curves are constructed showing the degree of speed or accuracy that should be attained by pupils of different ages or grades. Characteristic tests of motor skill are those employed in handwriting and typing, in which the elements of skill are emphasized.

Athletic Tests. Accomplishment in athletic performances has not yet been standardized to any great degree, though there are many methods employed for rating the performances of individuals. These methods involve setting up certain rules for the performer to follow and taking a record of the extent of his performance. This record may be compared with pre-established norms or with the best records that have been made by outstanding performers. The performances most frequently evaluated are jumping (standing and running), ball throwing (free style and overhead), running (50, 75, and 100 yards), chinning, and rope climbing. Tests have likewise been devised for measuring such "events" as lifting, vaulting, handling basketball (speed pass, goal shot, distance throw), baseball throwing, etc. Because of differences in natural abilities, separate norms have been worked out for boys and girls. Though considerable progress has been made in the measurement of athletic achievement, there is much to be done; and considerable work is being done in the field. (1)

Information Tests. Information tests exist in two types: tests of general information, and tests of specific information. The former type consists of items selected for current news, social practice, and the like, which are more or less generally known. The object of such tests is usually that of determining the degree of familiarity individuals have with current events. Specific information tests include items selected from special

fields of knowledge. Most tests of history, geography, science, etc., come under this heading.

PERSONALITY TESTS. Personality may de defined as the sum-total of human traits integrated according to a particular pattern in which some trait or set of traits stands out as a dominant characteristic of an individual. By concentrating attention on these dominant characteristics, which may be either inherited or acquired, test makers have sought to construct a large number and variety of tests for measuring them. In so far as acquired traits are measured, the tests are variously known as *character tests, attitude tests, social adjustment tests,* etc. Character tests are designed to measure such traits as honesty and deceit. Considerable attention, at least, has been given to methods of detecting tendencies in children to cheat, lie, and steal. One method employed is that of giving pupils puzzles to solve, which cannot be worked without peeping, and determining their degree of success. The extent of success is, of course, an indication of the amount of cheating. Another method involves giving different forms of a test with and without supervision. If the subjects make a higher score on the second than on the first, they show a tendency to cheat. A similar indication is found by letting pupils score their own papers which have already been scored without their knowledge, and noting the amount that they raise their scores. Lying has been measured by asking pupils who were known to have cheated on such tests as those just indicated, such questions as: Did you ever cheat on any kind of test? Did you ever change your grade or score on a test paper? Stealing has been studied by giving pupils an opportunity to take money, or to return change, without their knowing that they are being observed.

A consideration of the field of character measurement as a whole shows that it is still in the experimental stage. Though there is a pressing need for such tests, nothing has yet been produced which compares favorably with other types of standard tests. Some progress, however, has been made.

Greater success seems to have been achieved in the field of attitudes. A number of *attitude tests,* at least, have been constructed and standardized. These usually consist of "yes and no questions" concerning beliefs and convictions regarding religious, moral, and social practices and concepts. Work in this

field has been done principally on attitude toward war, social practices, religions, and various other moral issues. Many of the standardized tests previously discussed as measures of emotions belong in the present classification.

Tests for Grade Levels

Though a large number of standardized achievement tests are designed for several ages and school grades, many are designed for one or two grade levels. Tests so designed are very useful instruments, if a testing program does not need to extend over a wide range of grades. They are particularly useful in revealing the extent of differences between individuals, inasmuch as the subjects tested are of the same grade level and near the same ages. Moreover, because such tests are so limited, they are usually more detailed and accurate than are tests designed for several grades. Since tests for particular grades are similar in purpose and design to those discussed in previous classifications, it is not necessary to discuss each of the divisions of the present class separately. Suffice it to say that standardized tests are available for use by any teacher regardless of the number of grades she may be called upon to teach.

School Subjects Tests

From what has been said above, it is obvious that standardized achievement tests have been constructed for each of the various school subjects. Indeed, the number of such tests is very great. There is no one test, however, that covers all of the aspects of any one subject, for it is relatively impossible to construct a given test that will do this, particularly in the complex subjects. A discussion of each of several types will indicate what is meant.

ARITHMETIC TESTS. Arithmetic tests usually stress either the fundamental operations or the ability to solve problems. Tests of the fundamental operations contain representative examples in addition, subtraction, multiplication, and division. Problem-solving tests contain problems within the range of difficulty for the different grades. Thus one test may exist for this purpose, another for some other purpose; so that the teacher needs to choose carefully the appropriate test for the specific

purpose she wishes it to serve. Tests in algebra, geometry, trigonometry, etc., are also available.

READING TESTS. Reading tests have been constructed to measure a variety of functions. Some are designed for oral reading, others for silent reading. Within the field of oral reading, one test emphasizes phonetic elements and inflection; another emphasizes speed of comprehension. In silent reading, different tests emphasize such functions as the following: speed of reading, comprehension, memory, imagery, reading to answer questions, to appreciate the general significance of a paragraph, to understand precise directions, to note details, etc. The aim of each test, therefore, is to measure some aspect of reading.

HANDWRITING TESTS. As suggested above, handwriting tests are designed to measure the speed and quality of writing. Where quality is stressed, the test consists in asking a pupil to write a selected paragraph and to compare his product with graded samples. The accuracy of grading of this type of test is increased by having several graders or judges to decide upon the value of each pupil's writing and taking the average of the values assigned. Speed is emphasized by asking pupils to write as fast and as well as they can. The use of standardized scales in handwriting usually prompts the teacher to consider carefully not only the quality and speed but also the necessity of maintaining a balance of speed and quality.

LANGUAGE TESTS. Language tests may be sub-classified into such types as the following: (a) composition, (b) grammar, (c) literature, and (d) foreign language tests. Composition tests are designed to measure the ability of pupils to express themselves clearly and properly in writing. As in measuring the quality of writing, compositions written by pupils are compared with graded samples previously arranged in the order of merit. When making the comparison and grading the compositions of pupils, an examiner is urged to follow the instructions accompanying the scale. This is important in that different scales emphasize different aspects of composition. Some may stress general merit, while others may stress correctness of grammar. One scale contains samples of exposition and narration, and the grader is instructed to keep in mind structure and mechanics, as well as the thought content. Though subject to considerable inaccuracy in the case of individual graders, composition scales

prompt the teacher to give more accurate grades than she might otherwise give. They will, at least, suggest various standards that should be set for the pupils.

Grammar tests are highly objective and accurate in scoring. In these, items vary from a type which requires pupils to correct errors in a given paragraph to items which require them to choose a correct grammatical principle. Some tests also stress punctuation, spelling, and diction.

Foreign language tests vary not only from one language to another, but they vary also in emphasizing different aspects of language acquisition. Some tests stress pronunciation, others grammatical usage, others reading, and others composition. Foreign language tests are usually of high-school or college level.

HISTORY TESTS. History tests emphasize such functions as information, comprehension of material, evaluation of the importance of facts, chronological judgment, cause and effect relationships, thought and character judgment, etc. One test may contain items emphasizing one or more such functions; another test may emphasize one or several other functions. Though history has been covered fairly well by standardized tests, it has not been covered as thoroughly and satisfactorily as other school subjects. One reason for the shortage of tests is the lack of a standard content in history and the tendency for teachers of the subject to emphasize different groups of events. Some teachers, for instance, place a great deal of stress on local history. Besides, historians are not in complete agreement as to what is more important for children to know.

GEOGRAPHY TESTS. Geography is another subject about which there is little agreement as to content. Consequently, the number of standardized geography tests is not large. Those that are available, however, emphasize such functions as the following: ability to think about geography problems, cause and effect relationships, descriptions, trade routes, physical features of the earth, map location, and the like.

MISCELLANEOUS TESTS. From the foregoing discussion, it may be apparent that standardized tests are available for almost every school subject. Whatever is taught is capable of being measured and probably should be measured. There are various other standardized tests covering the subjects of science and its discussions, music, hygiene, cooking, sewing, shopwork,

stenography, and so on. In order to use any of these tests, however, it is necessary for the teacher to choose and emphasize the types of content and variety of functions that they emphasize. Since many teachers desire to stress content and functions other than those contained in the tests, many such tests are little used. (5)

Uses of Standardized Achievement Tests

Although a number of specific uses that may be made of standardized achievement tests have been suggested, it will be enlightening to summarize these and to mention others under various general headings. The most common uses are indicated and described below.

Grading

Though many teachers do not employ standardized achievement tests as a basis of grading pupils, they are none the less useful for this purpose. Grading, as we have seen, has to be done by ranking the pupils in the order of merit. Since standardized tests are the most accurate instruments for measuring pupil achievement, the rankings based on their scores are most accurate. Furthermore, the use of standardized tests for this purpose has a tendency to unify the content of various subjects taught by different teachers. When they know that pupils will be tested on particular skills or items of information, teachers will emphasize these in teaching; and the different teachers will tend to emphasize the same things. It is very unwise, of course, for teachers to study the content of standardized tests for the purpose of coaching pupils on their special content. The content should be studied, of course, to discover what topics or types of subject matter should be stressed. Coaching pupils to take a particular test is not only unwise, but is also poor policy and practice. Teachers should use standardized tests for the purpose of securing a true measure of the pupil's achievement or status.

The use of standardized tests for grading pupils does not tell the teacher what pupils, nor how many, have failed or passed. This matter should be based on other considerations. It is not unwise for the teacher to secure the judgment of school authorities or of other teachers as to the number of failures; and

she should use a variety of measures to determine who has failed. As a rule, school authorities suggest the maximum number that should fail, or pass, leaving the teacher to determine who they are.

Classification

By classification is meant two things: (a) assigning pupils to particular grades, and (b) sectionizing pupils within a given subject or grade. For either purpose, use should be made of both educational and mental test scores. Some schools grade and sectionize pupils on the basis of mental ages and intelligence quotients at the beginning, and later modify the assignments on the basis of achievement ages and quotients plus other facts. Other systems classify pupils on the basis of intelligence ratings plus other data. In either case, efforts are made to place the pupils in the proper grade and in the proper section within that grade or subject. The object of such placement is to form teaching groups made up of individual pupils as nearly alike in native ability and achievement as it is possible to find them. It is obviously easier to teach such a group than it is to teach a group in which there are wide variations in ability and achievement. Such grouping, at least, enables the teacher to handle larger classes and to make her teaching more effective.

Educational Guidance

Teachers and other school authorities are often called upon to help children decide upon courses of study to pursue or elect. This is particularly the case in high schools, where there are various electives and where pupils are being prepared for college or other courses. In order to offer sound advice, one needs all of the items of information available. The pupil's previous work and interests, the teacher's judgment of his ability and achievement, and his intelligence ratings are almost indispensable. A series of standardized test scores, however, will probably provide the most useful body of data. This is true because the pupil's achievement records can be compared with norms of wider derivation than the standards that may exist in the minds of the teachers. Usually, a pupil is advised not to take subjects of a type in which he has his poorest records, unless, of course, he has a high rating in intelligence or special

aptitude, which rating would mean he had not been working very hard in the courses previously pursued.

Dealing with Individual Cases

The teacher is often called upon, further, to deal with individual pupils who do not seem to fit into the regular program of the classroom. Sometimes a pupil seems to be capable enough to do the work, but he spends most of his time disturbing other pupils, or daydreaming. This pupil is frequently bored with class work because it does not challenge his ability. Other pupils are laggards for other reasons; some are too slow mentally to keep up with the class or have failed to master various fundamental skills and knowledge. Whatever the condition may be, the teacher needs a group of standardized tests designed to reveal ability, achievement, or difficulty. By applying such measures, she can at least secure data that will enable her to start to work without being entirely in the dark as to what to do with a problem case.

In many schools pupils of the type suggested are dealt with in *opportunity rooms* or other *special classes* under the supervision of a special teacher. This teacher, in particular, has considerable need of standardized instruments with which to isolate helpful data.

Motivation

Another use that may be made of standardized achievement test scores, which has been emphasized in other parts of this text, is that of motivation. This consists sometimes in letting pupils know their results in individual cases as well as the class average. Either, of course, may be compared with the norms; and the comparison may be used as a basis for arousing some lively competition. Most pupils are not only anxious to improve their own scores, but they are nearly always ready to make a strong effort to excel what other pupils are doing. By exhibiting charts and diagrams of progress and comparing these with the norms, therefore, it is relatively easy for a teacher to get her pupils to put forth their best efforts. At any rate, this is a much better type of appeal than that of stimulating pupils to strive for better grades. It is better because the standard can be set as high as the teacher desires to set it. As previously

suggested, no teacher should be satisfied when the pupils are attaining a level equal to the norms on a test. This may be a very low standard for some classes and a very high standard for others. Both teacher and pupils should be motivated to attain as high a standard as possible, whether it is the norm or the third quartile.

Diagnosis

As indicated above, by means of certain types of tests, teachers can use standardized achievement tests to diagnose pupil weaknesses and difficulties. This is a valuable use in that it may serve as a basis for remedial instruction and retraining. At any rate, detailed objective tests prepared for this purpose have been of considerable help to many teachers and pupils. The tests assist the teacher in discovering the most common difficulties met with by pupils; and the nature of the difficulty suggests the type of remedy to apply or the retraining that should be given.

Individualized Instruction

Many schools follow the practice of letting pupils progress through a subject or grade at a rate commensurate with their abilities. A bright pupil, for instance, is capable of completing a subject much more quickly than a dull pupil. Usually there are some who complete a unit, task, or lesson before others have fairly well begun. If their achievement is measured accurately, those who complete their work can be permitted to go ahead and to engage in some other activity. Moreover, slow pupils can be required to do additional work until their achievement scores are equivalent to the standard set for satisfactory work. It does not matter whether pupils are permitted to go ahead, to take other work, or required to do additional work; it is important to instruct them to proceed on the basis of accurate measures.

Experimental Work

The most extensive use made of standardized achievement tests is that involved in research work. This use was discussed somewhat at length in an earlier section of this text. There it

was pointed out that standardized tests are particularly helpful in all group experimentation. Having standard norms, it is possible to compare one group with another and both with a general standard in any situation requiring such comparison. Often teachers wish to change their teaching method to another which they believe will get better results. By making the change and holding all factors constant other than method, and by using standardized tests to measure the effects of the change, the teacher can determine which of the two methods is better. Superintendents, principals, State Boards, and others often desire to make comparisons among a great many schools. Regardless of the purpose, the safest standards of comparisons are the norms for standardized tests. Because these instruments are scientifically constructed and standardized, they are generally recognized as yielding measures sufficiently reliable for many and varied types of scientific investigation.

Specific Purpose

Many specific uses of standardized tests have been indicated above in the discussion of different types of tests. Suffice it to say here that teachers should select each test for the use or purpose for which it is designed. Otherwise, the interpretation and use of the results will be spurious. (6)

Limitations of Standardized Achievement Tests

Even though they are the most valid and reliable measures of achievement available, standardized achievement tests exhibit a number of limitations. Some of these should be pointed out.

Limited Range of Learning Products

Like teacher-made objective tests, standardized achievement tests fail to measure a variety of the desirable outcomes of teaching. Being objective, they fail to measure such abilities as the following: to organize thought, to make original comparisons, to summarize materials, to give explanation, to state and illustrate or apply general principles, to solve various types of problems, etc. They seem to stress the mechanical aspects of accomplishment, such as difficulty, quality, speed, accuracy, etc. Because they do this, their use tends to cause teachers to

overlook many other important outcomes of training and instruction.

They Have to Be Supplemented by Other Measures

The results of standardized achievement tests are practically useless, except when they are supplemented by other measures. This is especially true of the results of intelligence and special aptitude tests. As indicated above, a child's score on a test does not reveal what he should be expected to do, even though his score may equal or exceed the norm. Whatever the score, it should be evaluated in terms of the pupil's ability. Consequently, when a teacher gives an achievement test, her program of testing is only half completed; she must supplement the achievement test with a test of mental ability.

Prohibitive Costs

Most teachers and schools do not use standardized tests because they cost a considerable sum of money. The cost is particularly prohibitive when the teacher desires to use standardized tests for all of the purposes they are designed to serve. This is the chief reason why standardized tests are infrequently used, except for special survey and experimental purposes.

Untrained Examiners

Another practical limitation of standardized tests is the scarcity of trained examiners. Being warned that such tests are highly technical devices which must be given by persons trained for the task, many teachers and school authorities are slow to use them. While this is the case, every teacher should make an effort to acquire a workable knowledge of giving, scoring, and interpreting the results of standardized mental ability and achievement tests. There should be one teacher in each school, at least, who has had this type of training.

Other Limitations

There are probably many other limitations of standardized tests. For this reason they have not come into widespread use without a struggle. Many teachers are afraid to use them, realizing that the scores might reveal weaknesses in teaching.

Superintendents suffer from the same type of fear, in that their pupils might reveal poor training and instruction, and thus reflect upon the efficiency of the system as a whole. Though these are not specific limitations of the tests, they have occasioned much prejudice against their use and have been the basis of many invalid criticisms leveled at them.

EXERCISES

1. What is meant by *educational measurement?* What is the purpose of educational measurement?
2. Distinguish clearly between the *subjective* and the *objective* types of tests.
3. What is meant by the *personal estimate* type of grading? With what groups or levels of pupils is this method most extensively used? Why?
4. Which type of subjective test is most extensively used? How do you account for this?
5. What two general methods may the teacher use in administering objective tests? Indicate the relative values of the two methods.
6. Discuss: "The matching type of test is an excellent instrument to use for reviews."
7. On the basis of their respective merits compare the efficiencies of the true-false and the multiple choice tests as measuring devices.
8. Discuss: "Objective tests may be used for teaching as well as for testing."
9. Justify: "The *mixed type* is perhaps the most satisfactory type of teacher-made test to employ in any school subject."
10. Use some phase of your own major study as subject matter, and give five examples of each type of objective test described in this chapter.

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CHAPTER XXI

THE STATISTICS OF MEASUREMENT

INTRODUCTION

Purpose of the Chapter

The student at this point should recall that statistics is a branch of mathematics. As such, it is employed in the field of measurement for the purpose of arranging data and calculating such measures as the mean, standard deviation, and coefficient of correlation. In this chapter an effort will be made to acquaint the student with the fundamental principles employed in statistical computations and with the meanings and uses of various measures. When he studies such material, the student will become acquainted with important terms not yet introduced, and will discover how scores derived from tests may be described and presented.

There may be a few students who will feel considerable misapprehension at the prospect of a chapter containing some mathematical terminology. It should be emphasized at this point, therefore, that the mathematics to be presented is a relatively simple kind. It can be used successfully by any one who has a reasonable command of the fundamental operations in arithmetic and algebra. There are many operations of a very difficult nature in the field of statistics, but most of these will be left for mastery at more advanced levels. We shall confine ourselves in this chapter to the following topics: (a) the distribution table, or arrangement of data; (b) the calculation from the distribution table of such representative measures as the mode, median, mean, quartile deviation, and standard deviation; (c) the calculation of the coefficient of correlation; (d) the calculation of the probable error; (e) the construction and interpretation of distribution curves and diagrams, with emphasis on the meaning and description of the normal distribution curve; and (f) the values of statistical measures in studying trait variations and in educational research.

THE DISTRIBUTION TABLE

Description

Intervals and Frequencies

The arrangement of scores into groups is accomplished by constructing a *frequency* or *distribution table.* This is a tabular arrangement which shows the intervals into which scores are grouped and the frequency of occurrence of particular scores in each interval. The table usually shows the scale units and class intervals in a column to the left, and the number of cases falling between selected points on the scale in a column to the right. Sometimes the class intervals are arranged in a horizontal column with the frequencies shown beneath. Examples of the two arrangements are exhibited in Tables I and II below.

TABLE I. DISTRIBUTION OF THE HEIGHTS OF 1000 12-YEAR-OLD BOYS

(Usual Arrangement)

CENTIMETERS (CLASS INTERVALS)	f (FREQUENCIES)
158–163	6
154–157	33
150–153	101
146–149	211
142–145	292
138–141	216
134–137	97
130–133	38
126–129	6
	$N = 1000$

TABLE II. DISTRIBUTION OF THE HEIGHTS OF 1000 12-YEAR-OLD BOYS

(Horizontal Arrangement)

CENTIMETERS								
126 129	130 133	134 137	138 141	142 145	146 149	150 153	154 157	158 163
FREQUENCY								
6	38	97	216	292	211	101	33	6

Construction

In order to construct a distribution or frequency table, such as exhibited above, one may proceed as follows: (a) Find the *range* of the scores by subtracting the highest from the lowest. (b) Decide upon the number of *intervals*, classes, or groups into which the range can be conveniently and usefully divided. This number should not be less than five nor more than twenty. (c) Divide the range by the number of intervals decided upon, and thus find the size of the *class interval.* The most convenient intervals usually contain five or ten units, though they may

contain a greater or less number, depending on the size of the range. A narrow range would permit smaller class intervals than a wide range of scores, and vice versa. (d) Arrange the intervals in successive order, each containing the same number of units, and tabulate the measures in order to find the *number of measures* that fall into each interval. (e) Count the number of cases falling in each interval, and show this number in a *frequency column* to the right.

Illustration

The steps just indicated are illustrated below by using the I.Q.'s of 72 college freshmen in a Southern university.

TABLE III. ILLUSTRATING THE CONSTRUCTION OF A DISTRIBUTION TABLE OF THE I.Q.'S OF 72 COLLEGE FRESHMEN

Ungrouped Data				Class Intervals	Tabulation	Frequency
107	131	121	117	140–149	II	2
126	128	113	89	130–139	III	3
120	113	110	120	120–129	𝍸 𝍸 𝍸 I	16
114	107	98	114	110–119	𝍸 𝍸 𝍸 𝍸 𝍸	25
116	105	116	125	100–109	𝍸 𝍸 𝍸 II	17
96	110	126	97	90– 99	𝍸 II	7
102	120	122	112	80– 89	II	2
129	113	119	110			
113	127	120	105			
99	116	102	117			
117	111	132	121			
132	104	104	99			
124	115	106	101			
101	118	101	106			
115	113	100	105			
109	141	126	124			
91	105	117	116			
94	119	83	148			

The column at the left shows the I.Q.'s as they were copied from a professor's roll book in which the names of the students were arranged in alphabetical order. The measures, as copied, are *ungrouped*, revealing no semblance of orderly arrangement. In this form, the measures are difficult to study. The second column shows the size of the class interval decided upon. This was found by subtracting the lowest I.Q., 83, from the highest, 148, to obtain the *range* of 65. This range, it was clear, could be divided into 7 intervals of 10 units each. Then the intervals were set down, as shown. Then the scores were tabulated

by making a single mark for each, as shown, so that each of the scores would appear in some one unit. When this was accomplished, the *frequency column* at the right was made by counting the separate marks opposite each class interval.

Leaving out the ungrouped scores and the tabulation, we have the distribution or frequency tables shown in Table IV.

TABLE IV. SHOWING THE I.Q.'S OF 72 COLLEGE FRESHMEN

Interval I.Q.	Frequency
140–149	2
130–139	3
120–129	16
110–119	25
100–109	17
90– 99	7
80– 89	2

TABLE V. SHOWING THE PERCENTAGE OF I.Q.'S OF THE TOTAL POPULATION (Approximation)

Interval I.Q.	Frequency
130+	1%
120–129	5%
110–119	14%
100–109	30%
90– 99	30%
80– 89	14%
70– 79	5%
0– 69	1%

Suggested Values of the Distribution Table

What facts may be deduced quickly and easily from Table IV? Is this table of any special value compared with the mass of ungrouped scores in the first column of Table III? What facts regarding the intelligence of college freshmen will a comparison of Table IV with Table V reveal? Would this comparison be easier if the frequencies in Table IV were reduced to percentages? Can this be done? Summarize the values of a distribution table.

THE CALCULATION OF MEASURES

Types of Measures

A distribution table is not only a convenient way of arranging a large number of ungrouped measures so as to exhibit significant facts and comparisons; *it is also the starting point for the calculation of a variety of particular numbers* each of which will represent specific features of all the measures. These numbers are: (a) certain measures of *central tendency*, including the mode, median, and mean; and (b) measures of *spread*, *dispersion*, or *variability* of a total group of measures, such as the quartile and

standard deviation. Because of the extensive use made of such measures in educational literature, it will be worth while to note how they are calculated, and to observe their meanings and uses.

The Mode

Calculation

The term *mode* in statistics is used to refer to the measure that occurs most frequently in a group of measures. In the distribution of I.Q.'s presented in Table III, for example, the *mode* is 115, the midpoint of the class interval containing the greatest number of cases. In Table IV, the mode is 100, the number around which there is the greatest percentage of cases. What would the mode be in the following series: 25, 24, 23, 22, 21, 20, 20, 19, 19, 19, 18, 17, 16, 15, 8?

Uses

The mode is a useful measure of central tendency in two types of instances: (a) when one particular measure or value occurs a large number of times near the center of the distribution, and (b) when two or more values occur a large number of times in different parts of the distribution. In the second instance, the distribution is *bi-modal* or *tri-modal,* etc. By this is meant that the measures cluster about two or more modes. In the following group of grades, for example, there are two modes: *A A A B B B B B B B C C D D D D E E E E E E E F F G.* Here the grades *B* and *E* are modes. Here the modes show that there are two grades that occur a large proportion of times.

The Median

Calculation

When a series of scores is arranged in ascending or descending order (from lowest to highest or highest to lowest), the median is obtained by finding the middle score. When there is an odd number of measures, the median is the middle measure; when there is an even number of measures, the median is the value midway between the two middle measures. This method of finding the median is convenient enough when there is a small number of measures, as 20 or 30. When the number of meas-

ures is larger, it is more convenient to make a distribution table and compute the median from it. The computation consists of finding the value on the scale that divides the number of measures into two equal parts. The method is illustrated in Table VI showing the distribution of I.Q.'s presented in Table IV.

TABLE VI. ILLUSTRATING THE CALCULATION OF A MEDIAN

I.Q.	f		
140–149	2	(a) $\frac{N}{2} = \frac{72}{2} = 36$	(a) $\frac{N}{2} = \frac{72}{2} = 36$
130–139	3	(b) $2 + 7 + 17 = 26$	(b) $2 + 3 + 16 = 21$
120–129	16	(c) $36 - 26 = 10$	(c) $36 - 21 = 15$
110–119	25	(d) $10 \div 25 = 0.4$	(d) $15 \div 25 = 0.6$
100–109	17	(e) $0.4 \times 10 = 4.0$	(e) $0.6 \times 10 = 6.0$
90– 99	7	(f) $110 + 4.0 = 114.0$	(f) $120 - 6.0 = 114.0$
80– 89	2	md. = 114.0	md. = 114.0

Summary of Steps

Two methods are illustrated, either of which may be followed. The steps taken in the first may be summarized as follows: (a) Divide the number of cases by 2. $\frac{N}{2} = \frac{72}{2} = 36$. This shows the number of cases on either side of the midpoint in the scale. (b) Find by inspection the middle interval or the one that probably contains the midpoint. In the problem this interval appears to be 110–120. (c) Determine the sum of the cases below the interval by adding the frequencies, e.g., $2 + 7 + 17 = 26$. This number does not and should not exceed half the cases. (d) Subtract this sum from half the number of cases, e.g., $36 - 26 = 10$. The result is the number of cases in the interval assumed to contain the median that must be used to find the point on the scale which equally divides the number of cases. (e) Divide this result by the number of cases in the middle interval, e.g., $10 \div 25 = 0.4$. This is the proportion of the number of cases in the class interval assumed to contain the median and to be used in finding the midpoint. (f) Convert this proportion into scale units by multiplying by the number of points in each class interval, e.g., $0.4 \times 10 = 4.0$. (g) Add these scale points to the lowest point in the middle class interval, e.g., $110 + 4.0 = 114$. The result is the median.

The second method illustrated in Table IV is essentially the same as the first, except for two important differences: First, in

taking step (b), add the frequencies above the middle interval; and second, in taking step (f), subtract the number of points from the upper limit of the middle interval. The median is the same. It is not necessary to follow both methods, unless the calculator wishes to verify the answer obtained by one or the other.

Uses

The median is used primarily for the following purposes: (a) to compare the status of one group with that of another; (b) to compare the performance of a group with the norms of a standardized test, when the norms are given as medians; (c) to indicate the position of individuals in regard to the group as a whole, that is, to determine whether one is in the upper or lower 50 per cent of the cases.

The Mean

Calculation

The *mean* is usually found by dividing the sum of all the measures in a group by the number of cases. The formula is $M = \frac{\Sigma m}{N}$, in which Σ is the sign for "sum of" and N is the number of cases. This is a simple method of computation, but it is rather cumbersome and slow when a large number of cases is being considered. A much shorter method is illustrated in Table VII, showing how the mean is calculated from a distribution table.

TABLE VII. ILLUSTRATING THE SHORT METHOD OF COMPUTING THE MEAN

I.Q	f	d	fd	CALCULATIONS
140–149	2	3	6	$6 + 6 + 16 = 28$
130–139	3	2	6	$-6 + (-14) + (-17) = -37$
120–129	16	1	16	Alg Σ $28 - 37 = -9$
110–119	25	0		$\frac{\Sigma}{N} = \frac{-9}{72} = -.125C$
100–109	17	−1	−17	$-.125 \times 10 = -1.25 = C$
90– 99	7	−2	−14	$105 - 1.25 = 103.5 = M$
80– 89	2	−3	− 6	

In order to find the mean by this method, take the following steps: (a) Assume a mean, usually the midpoint of the middle interval or of the interval containing the largest number of cases. In Table VII, this point is 105. (b) Treat each class

interval as a unit, and indicate the number of these units that the midpoint of each class interval deviates from the assumed mean. Consider the numbers above the assumed mean as positive deviations, and those below it as negative deviations. Arrange these as column "*d*." (c) Multiply each deviation by the corresponding frequency, getting the column shown as "*fd*." (d) Find the sums of the positive and negative *fd*'s; e.g., 28 and −37 above. (e) Divide the algebraic sum of these sums by the number of cases. The quotient is the mean of the deviations from the assumed or estimated mean, in units of whole class intervals. (f) Multiply this mean by the number of units in a class interval, as $-.125 \times 10 = 1.25 = C$. (g) If the C, or correction, is negative, as in the example, subtract it from the assumed mean to get the *true* mean; if C is positive add it to the assumed mean to get the true mean.

Uses

The mean is usually considered the most useful and accurate of the measures of central tendency. This is true because all of the different cases enter into its computation. In other words, it is calculated rather than found by counting, as are the median and mode. It is used for essentially the same purpose as the median.

The Quartile Deviation

Definition

The *quartile deviation*, or *semi-interquartile range*, is a measure of variability or spread of the cases in a distribution. It is half the range between two points, called *lower quartile*, Q_1, and *upper quartile*, Q_3, and it contains half or 50 per cent of all the measures. Q_1 is a point on the scale that marks off the lower 25 per cent of the cases, and Q_3 is a point that marks off the upper 25 per cent of the cases. The median, which divides the cases in half, is Q_2.

Calculation

The calculation of the quartile deviation involves the following steps: (a) Compute the lower quartile, Q_1. (b) Then compute

the upper quartile, Q_3. (c) Subtract Q_1 from Q_3. (d) Divide the result of (c) by 2. The formula is as follows: Q.D. $= \frac{Q_3 - Q_1}{2}$.

The steps in the calculation Q_1 and Q_3 are similar to those taken in finding the median, except that these points mark off one-fourth instead of one-half of the cases. The calculations are illustrated in Table VIII.

TABLE VIII. ILLUSTRATING THE COMPUTATION OF THE QUARTILE DEVIATION, Q.D.

I.Q	f	Q_1	Q_3
140–149	2	(a) $72 \times .25 = 18.00$	$72 \times .25 = 18$
130–139	3	(b) $18 - 9 = 9$	$18 - 5 = 13$
120–129	16	(c) $9 \div 17 = .53$	$13 \div 16 = .812$
110–119	25	(d) $.53 \times 10 = 5.3$	$10 \times .812 = 8.12$
100–109	17	(e) $100 + 5.3 = 105.3$	$130 - 8.12 = 121.88$
90– 99	7	$= Q_1$	$= Q_3$
80– 89	2	$\frac{Q_3 - Q_1}{2}$	$= \frac{121.88 - 105.30}{2}$
	$N = 72$		$= 8.29$
			$=$ Q.D.

Steps in Calculation Q_1

(a) Find 25 per cent of the number of cases. $72 \times .25 = 18.00$. (b) Add the f's from the bottom up to the interval that will contain the point marking off 25 per cent of the cases, or to the interval that will contain Q_1. $7 + 2 = 9$. (c) Subtract the number from 25 per cent of the cases. $18 - 9 = 9$. (d) Divide the remainder by the number of cases in the class interval assumed to contain Q_1. $9 \div 17 = .53$. (e) Multiply this quotient by the number of units in the class interval. (f) Add this product to the number representing the lower limit of the class interval. The result is Q_1, or 105.30.

Steps in Calculation Q_3

(a) Find 25 per cent of the cases. E.g., $72 \times .25 = 18$. (b) Add the f's from the top down to the interval which contains the point that will mark off 25 per cent of the cases, or Q_3. $13 \div 16 = .812$. (c) Multiply this quotient by the number of units in the class interval. $10 \times .812 = 8.12$. (d) Subtract this product from the number representing the upper limit of the class interval assumed to contain Q_3. The result, of course, is Q_3 or 121.88.

of the distribution used as an example above, what would we know about the distribution? The range of I.Q.'s is from 80–150; the mean is 103.27; and σ is 12.22. Does this information mean anything? First, let us note that $M - 2\sigma = 103.27 - (2 \times 12.22) = 78.83$; while $M + 2\sigma = 103.27 + (2 \times 12.22) = 127.71$. $M + 3\sigma = 103.27 + (3 \times 12.22) = 139.93$. This simple calculation reveals that a distance of 2σ below the mean will not take us to the upper limit. Even if we add 3σ to the mean, the point arrived at will not be far enough to include all of the cases. Thus, the σ tells us two things about the distribution: (a) the mean is considerable distance below the center of the range; and (b) the majority of cases are clustered at the lower end of the scale, because they cluster about the mean. Thus, given only three measures, one can get a fairly definite idea of a distribution as a whole. This idea is of particular value, moreover, in comparing one distribution with another. For example, if the σ's of two different distributions are given, and one σ is larger than the other, one knows that the scores which have the larger σ are more scattered than those having the smaller σ. Because of such implications of these measures, writers frequently give no other data concerning a large number of cases.

Sigma is used also in finding various other statistical measures that we shall not attempt to describe here.

CORRELATION

Meaning

General Concept

The concept of correlation is present in the thinking of both the layman and the statistician. If we say that tall men are likely to be heavy, we mean that there is a correlation between the height and the weight of such men. Similarly, if we say that intelligent children are likely to do better school work than dull ones, we mean that there is a correlation between intelligence and ability to do school work. For example, if we should find that the brightest children in a group of one hundred had the highest grades, the next brightest had the next highest grades, those of mediocre brightness had the next highest, and so on down to the dullest, we should know that there is a very

high correlation between the traits of brightness and achievement. On the other hand, if we should find that some dull and mediocre children had highest grades, and that some bright children had low grades, we should know that the correlation is not very high. There might be a tendency for the measures of intelligence and achievement to correspond, but the correspondence would be small.

Statistical Concept

The statistical concept of correlation includes the computation and use of the *coefficient of correlation.* This term is used to express the *extent* to which one factor varies in relation to variations in another or other factors. In other words, the coefficient of correlation is a number expressing the degree of correspondence between two measures. Because of the manner in which it is computed, this number or coefficient is usually a fraction between 1.00 and −1.00. If the measures of one trait or factor tend to increase in proportion as the measures of a second factor increase, the coefficient, or the correlation, is positive; if there are no exceptions to this tendency, the coefficient is 1.00 and the correlation is perfect. If there is no relationship between the two sets of measures, the coefficient is 0. If, on the other hand, the measures of one trait tend to increase in proportion as the measures of a second trait decrease, the correlation is negative. If there are no exceptions to the tendency, the coefficient is −1.00, which is a perfect negative correlation. Any fraction between 1.00 and −1.00, therefore, indicates the degree of positive or negative correlation existing between two sets of measures. Such fractions are usually designated as .97, .76, .54, .20, −.10, −.30, −.65, or −.88. The fraction is usually preceded by the letter r, which symbolizes *coefficient of correlation.*

Interpretation of r

The coefficient of correlation is usually interpreted in such terms as "very high," "high," "marked," and "low." "Very high" correlation is indicated by coefficients above .80; "high" correlation by coefficients from .60 to .79; "marked or moderate" correlation by coefficients from .40 to .59; "low" correla-

tion by coefficients below .40. These ranges of coefficients suggested are by no means definite. They are only suggestive.

Calculation of the Coefficient of Correlation

There are several methods for computing *r*. One is the Spearman *rank-difference* and *foot-rule* method; another is the *product moment* method. There are others, but these are the simplest and the ones most commonly followed. The Spearman methods will be explained first.

Spearman Rank-Difference and Foot-Rule Methods

The Spearman method of computing the coeffiicent of correlation consists of two slightly different procedures, one of which is called the *rank-difference* method, and the other the *foot-rule* method. Since these are very similar procedures they may be explained by an illustration. The steps in the procedure involve (a) arranging the measures to be correlated so that they reveal the rank of each measure in each series, (b) finding the differences between the ranks, and (c) substituting obtained quantities in one or the other of the following formulas:

$$\rho = 1 - \frac{6\Sigma D^2}{N\,(N^2 - 1)}$$

or,

$$R = 1 - \frac{6\Sigma g}{N^2 - 1}$$

Since the coefficients resulting from the two methods differ slightly from those resulting from the product moment method, it is customary to designate the rank-difference coefficient by ρ, and the foot-rule coefficient by "*R*."

In order to illustrate the methods of calculation, let us suppose that a class has been given an intelligence and reading test, and that it is desired to correlate the I.Q.'s and reading scores. Suppose, further, that the I.Q.'s of the pupils were as follows: 107, 126, 120, 114, 116, 96, 102, 129, 113, 99, 117, 132, 124, 101, 115, 109, 91, 91, 131, 128; and that the reading scores were as follows: 35, 47, 40, 36, 34, 20, 34, 53, 33, 23, 37, 53, 43, 26, 31, 28, 17, 14, 53, 44. The two series of scores are set down for the various pupils just as they appeared in an instructor's record book;

the first pupil had an I.Q. of 107 and a reading score of 35; the second pupil an I.Q. of 126 and a reading score of 47; and so on. It is necessary to keep the two scores for each pupil arranged so that they are always known to be made by the same pupil.

The first step is to find the rank of each measure in each of the series. In order to do this each series of scores may be arranged in the order of decreasing size. When this is done, it is easy to assign each its proper rank in the series from 1 to 20. When two or more scores are the same, find the median of these scores and assign them this median rank.

Tabulate the scores to show the names or numbers of the pupils in the first column, the I.Q.'s in the second column, the rank of each I.Q. in the third, the reading scores in the fourth, the rank of each reading score in the fifth, the difference between the ranks in the sixth (column D), and each difference squared in the seventh (column D^2).

TABLE X. TABULATION OF RANK DIFFERENCES

PUPILS	I.Q.	RANK	READING	RANK	D	D^2
1	107	14	35	10	4	16
2	126	5	47	4	1	1
3	120	7	40	6	1	1
4	114	11	36	9	2	4
5	116	9	34	11.5	−1.5	2.25
6	96	18	20	18	0	0
7	102	15	34	11.5	3.5	12.25
8	129	3	53	2	1	1
9	113	12	33	13	−1	1
10	99	17	23	17	0	0
11	117	8	37	8	0	0
12	132	1	53	2	−1	1
13	124	6	43	6	0	0
14	101	16	26	16	0	0
15	115	10	31	14	−4	16
16	109	13	28	15	−2	4
17	91	19.5	17	19	0.5	0.25
18	91	19.5	14	20	−0.5	0.25
19	131	2	53	2	0	0
20	128	3	44	4	−1	1
N-20					Σg-13.0	61.00

When he inspects Table X, the student will find that pupils who made the same scores have been given the same ranks. The pupils having I.Q.'s of 91, for instance, were given a rank of

19.5; and the pupils making reading scores of 53 were given a rank of 2, or the median rank of the three. Note that N equals 20, which is the number of pupils; that Σg is the sum of the positive differences shown in column D; that the ΣD^2 is the sum of the numbers in column D^2. These numbers are the squares of the differences between the ranks.

By substituting these quantities in the formula for ρ, we have:

$$\rho = 1 - \frac{6\Sigma D^2}{N(N^2 - 1)}$$
$$= 1 - \frac{6 \times 61}{20(20^2 - 1)}$$
$$= .95$$

This coefficient should be interpreted as very high. When it is used with reference to the measures from which it was calculated, it means that pupils having high or low I.Q.'s tend to make high or low grades, respectively, in reading. The method of calculation is the Spearman *rank-difference method.*

By substituting the quantities in the formula for R, we have:

$$R = 1 - \frac{6\Sigma g}{N^2 - 1}$$
$$= 1 - \frac{6 \times 14.5}{(20)^2 - 1}$$
$$= .78$$

This method of finding the degree of correlation between two sets of measures is known as the Spearman *foot-rule method.* In this case the method yielded a much lower coefficient than did the rank-difference method.

If we summarize the steps taken in the calculation of ρ and R, we have: (a) Rank both series of measures in the order of size, beginning with the highest or the lowest. If two or more measures in either series are the same, find the median rank and give each measure this rank. (b) Tabulate the scores and ranks as shown in Table X. (c) Subtract the rank of each measure in one column from the rank of the corresponding measure in the other. (d) Call the difference D, and record in the appropriate column to the right of the columns of measures and ranks, tabu-

lating each difference as positive or negative. (e) Square each of the differences, and place these squares in appropriate places in column D^2 to the right of column D. (f) Find the sum of column D^2, getting ΣD^2; or find the sum of the positive D's, getting Σg. (g) Substitute the quantities in the proper formula, letting N stand for the number of cases in each series. (h) Find ρ or R.

USES OF ρ AND R. Though the calculation of ρ is somewhat more complicated than R, the coefficient obtained by the first method is usually regarded as being more accurate than that obtained by the second. Neither method is used in dealing with a large number of measures, however; unless the original measures are in the form of ranks instead of actual scores. In this case the rank-difference methods are desirable. When the data are in the form of actual scores, these methods are used in dealing with less than 30 or 40 cases. When the number of cases exceeds 30 or 40, the product moment method, described below, is employed. The advantage of the latter method over those already described is chiefly that the coefficients are more accurate and dependable.

Because of the higher degree of accuracy of the product moment coefficients, as well as the need for comparing ρ and R with r, methods of converting ρ and R into r have been devised. Tables for this purpose may be found in H. O. Rugg's *Statistical Methods Applied to Education, Appendix,* and other standard statistics textbooks.

The Product Moment Method

The product moment method consists in arranging two sets of data so as to secure quantities which can be substituted in the following formula:

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \cdot \Sigma y^2}}$$

In the formula x is the difference between the average of one distribution and any measure in the distribution, and y is a like difference for the other distribution. The method of calculating r is illustrated in Table XI, in which the data employed in finding ρ and R above have been presented.

TABLE XI. ILLUSTRATING THE PRODUCT MOMENT METHOD OF CALCULATING THE COEFFICIENT OF CORRELATION

Pupil	I.Q.	Tabulation of Reading	x Difference in I.Q.'s from Average	y Difference in Reading Scores from Average	x^2	y^2	xy
1	107	35	− 6	0	36	0	0
2	126	47	13	12	169	144	156
3	120	40	7	5	49	25	3
4	114	36	1	1	1	1	1
5	116	34	3	− 1	9	1	−3
6	96	20	−17	−15	289	225	255
7	102	34	−11	− 1	121	1	11
8	129	53	16	18	256	324	288
9	113	33	0	− 2	0	4	0
10	99	23	−14	−12	196	144	168
11	117	37	4	2	16	4	8
12	132	53	19	18	361	324	342
13	124	43	11	8	121	64	88
14	101	26	−12	− 9	144	81	108
15	115	31	2	− 4	4	16	−8
16	109	28	− 4	− 7	16	49	28
17	91	17	−22	−18	484	324	396
18	91	14	−22	−21	484	441	462
19	131	53	18	18	324	324	324
20	128	44	15	9	225	81	135
Average	113	35			3,305	2,577	2,996

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \cdot \Sigma y^2}} = \frac{2794}{\sqrt{3305 \times 2577}}$$

$$= \frac{2794}{\sqrt{8516985}} = \frac{2794}{2918.36} = .957$$

$$r = .957$$

$$\text{P.E.} = 6745\,\frac{1 - r^2}{\sqrt{N}} = .6745\left(\frac{.084151}{4.472}\right) = .0129$$

The steps illustrated in Table XI may be summarized as follows: (a) Tabulate the scores for each pupil as in the first three columns. (b) Find the mean of each distribution. (c) Find the difference between each measure in each series and the mean

of the corresponding measures. (d) Tabulate these differences in x and y columns. (e) Find xy, and tabulate in a final column. (f) Find the sums of columns x^2, y^2, and xy. (g) Substitute each of the sums in the formula, and solve for r.

A method employed for the purpose of eliminating a part of the arithmetical labor involved is that of subtracting the smallest x score from all the other x scores, and the smallest y scores from all the other y scores, and then correlating these smaller numbers. Since the reduced scores are still in the same rank order, the correlation coefficient will be the same. In Table XI, for instance, we could reduce all the I.Q.'s by 91, the lowest, and all of the reading scores by 14, the lowest; and thus reduce the size of the numbers to be squared and extended to x^2 and y^2 columns. This device is used when the original scores are relatively large.

The Reliability of r—The Probable Error

It may be apparent to the student that any specific r tends to fluctuate. Its size is determined not only by the degree of correlation between two sets of data but also to some extent by the number of cases in the series. In other words, the reliability of the coefficient is greater when it is calculated from a larger number. Moreover, we do not know whether the same coefficient would be obtained if we were to calculate it for two or more sets of similar data. For instance, would the coefficient obtained in the calculations made in the foregoing illustrations be the same as one calculated from another group of I.Q.'s and reading scores obtained from a different group of pupils? In order to determine whether this is the case, we might take many classes of pupils and compute the r's. This, of course, would be impracticable. It is possible to determine the statistical reliability of a coefficient by calculating its *probable error* or *P.E.* The P.E. is a number which may be added to or subtracted from the mean of a distribution to find the limits on the scale between which one-half the cases fall. If this number is calculated for a particular coefficient of correlation, it will show the degree of probability which that coefficient sustains in relation to any number of additional coefficients that might be calculated from similar groups and from similar data. If the probable error is found for a particular correlation, the coefficient should be at

least four times as large as the P.E. The P.E. is calculated by means of the following formula:

$$\text{P.E. of } r = .6745\ \frac{1 - r^2}{\sqrt{N}}$$

Values and Uses of Correlation Coefficients

The coefficient of correlation is an indication of a relationship between two groups of measures. It is a measure of mutual implication. It is computed from the facts gathered and these are usually only a small sample of the facts which are available. It is likely that coefficients computed from successive samples will not be identical.

The degree or amount of relationship is indicated by the size of the coefficient. It has been mentioned above that coefficients may range from -1.00 to $+1.00$ and the values of the various quantities within this range have been indicated. It should be pointed out, however, that whether a coefficient is considered high or low may depend, in part, upon other coefficients with which it is compared.

Coefficients of correlation do not necessarily indicate causal relationships. Neither do they always indicate no causation. It is possible to have coefficients which are not the results of causation, as well as those which are. Correlations might be computed between the size of men's shoes and their I.Q.'s, or between the number of rooms in a house and the telephone number, or between the weight of men and the amount of money in their pockets. It is quite obvious that these factors are not causally related. On the other hand, a correlation might be shown between the height of a candle and the number of hours it has burned, or between the height of children and their chronological ages, or between scores made on reading tests and those made on arithmetic tests. It may be suspected that the coefficients from these factors are, in part, the results of causation. It is probably wise not to describe correlation with respect to causal relationships. It is preferable to describe it as correspondence between two groups of measures.

Coefficients of correlation have many uses. Some are:

1. To indicate the reliability of a test.
2. To indicate the validity of a test.
3. To indicate the relationship between abilities.

4. To indicate the relationship between capacities.

5. To indicate the quantitative extent of mutual implication between two groups of data, for example: to indicate the amount of agreement between a test and the teacher's judgment, or between school grades and success in after life, or between grades in two or more subjects. The larger the coefficient, the closer the relationship. To predict future data in one factor upon the basis of known scores in the other, is another use.

DISTRIBUTION CURVES AND DIAGRAMS

Methods of Exhibiting Variations

In addition to the construction of distribution tables and the calculation of various measures of central tendency and variability, statistics is concerned with methods of exhibiting variations. These methods involve the use of various graphic representations of distribution tables, averages, and deviations, by which such are presented in units of space. The graphs most commonly employed for this purpose are known as *distribution curves* or *frequency diagrams*, which may assume the form of a frequency polygon or bar-graph.

Construction

General Procedure

All distribution curves are made from data previously organized into distribution tables. The first step is the construction of a distribution table. After this is done, the following steps may be taken: (a) On cross-section paper, draw a horizontal line across the bottom of the page. (b) Divide the line into as many units as there are class intervals in the distribution table, placing the division points as far apart as the paper will conveniently permit. (c) Place under each point the number that represents the lower limit of each of the class intervals. (d) Then draw a perpendicular line at the left end of the first line. (e) Divide this line into a number of units by which the number of cases in each class interval can be represented. For instance, a small square on the cross-section paper may represent one, two, three, or any number of cases. (f) After determining the scales, locate a point to represent the number of squares necessary to represent the number of cases in the first interval, and locate a point representing this number on the perpendicular which cuts

the horizontal line midway between points representing the first interval. Do this, then, for each interval.

Interpretation

The line forming the polygon should be interpreted in relation to the base line. It can be seen, in Fig. 35, for instance, that the largest number of cases falls between 110 and 120, and that the number of cases on either side of the high point becomes increasingly less in the intervals to the left and right of this interval. Just a glance at the curve will, then, reveal the essential features of the distribution without the necessity of examining the particular measures.

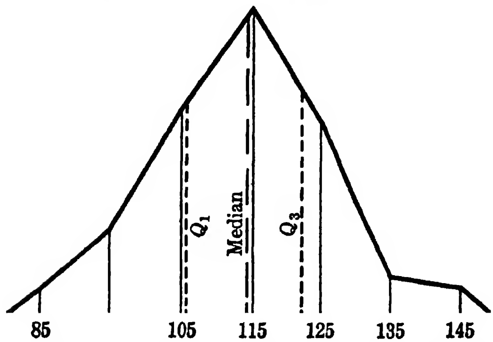

FIG. 35. Frequency polygon showing distribution of I.Q.'s of 72 college freshmen. Quartiles and median are shown.

We may add to the amount of information contained in a curve of this kind by indicating the position of any of the measures discussed above. Figure 35, for instance, shows the median and Q_1 and Q_3. The perpendicular cutting the base line at these points and the upper line divide the enclosed space into approximately equal parts. The points so located may now be used to make either of the three types of distribution curves described below.

Types of Curves

The Frequency Polygon

The *frequency polygon* is a figure resulting from connecting the points located above with straight lines. It is called a polygon because of its appearance as a figure having many sides. Figure 35, for example, is a frequency polygon constructed from the distribution table used in the calculations described above.

The Column Diagram

Another method of illustrating the data contained in a distribution table is by the ***distribution chart*** or ***column diagram.*** Such a diagram is illustrated in Fig. 36.

The advantage of this type of graph is that it shows accurately rather than approximately the number of cases in a class interval, and that it is easily read and interpreted. It is used frequently to show the distribution of measures, when this is a particular point of interest.

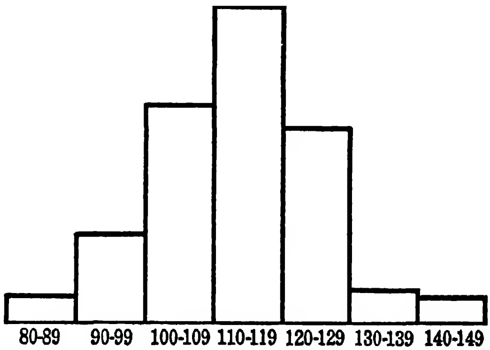

FIG. 36. Column diagram showing distribution of I.Q.'s of 72 freshmen.

The Bar-Graph

Still another method of presenting data is by means of the bar-graph. This is very similar to the column diagram, except that the horizontal spaces are not emphasized. Vertical distances are important in it. An example is shown in Fig. 37.

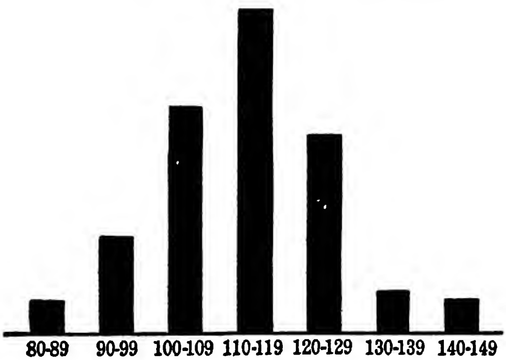

FIG. 37. Bar-graph showing distribution of I.Q.'s of 72 college freshmen.

The Normal Distribution Curve

MEANING AND DESCRIPTION. It will be observed that all of the curves and charts illustrated above show a general tendency for the data contained in a distribution table to vary from a

large number of cases on either side. In an ideal distribution, the number of cases on either side of the mean is the same and the variations from the mean follow certain laws of probability or of chance. It will not be necessary to state these here, except to say that strictly chance variations are the basis of an ideal curve known as the *normal distribution curve*. This is a bell-shaped curve in which every part or point sustains a constant relation to the base line; and each statistical measure located on this curve bears a definite relation to each of the other measures and to the whole. Such a curve is presented in Fig. 38, which shows the position of the mean and the sigma and the percentage of cases falling into units of the curve separated by perpendiculars erected at sigma points.

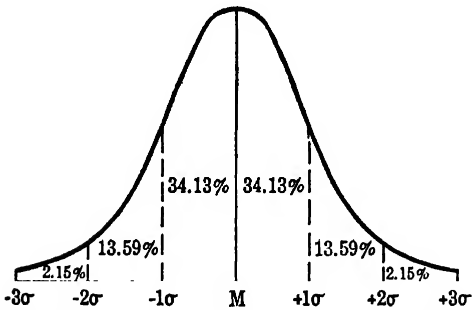

FIG. 38. A normal distribution curve showing sigmas and mean (M).

VALUES AND USES. The chief facts of interest about this curve are the following: (a) A perpendicular erected from the mean divides the total area into equal parts. (b) A perpendicular erected at $+1\sigma$ or -1σ from the mean cuts off an area that contains 34.13 per cent of the total and the space between these two perpendiculars contains 68.26 per cent of the total. (c) A distance of 4σ (from $+2\sigma$ to -2σ) contains 95.44 per cent of the total area. (d) A distance of 6σ (from $+3\sigma$ to -3σ) includes 99.73 per cent of the total area, or nearly all of the cases. These are a few facts arrived at by elaborate calculations which we do not need to consider here. If we remember these facts, however, they will help us to determine to what extent a particular curve approaches the ideal. In other words, the ideal distribution curve is a kind of standard by which any actual curve is evaluated.

In determining whether a curve constructed from actual data approaches the ideal, we observe the following points: (a) Is the curve fairly symmetrical or smooth? (b) Does a perpendicular erected at the mean divide the area subtended by the curve into

approximately equal parts? (c) Does the distance between $+3\sigma$ and -3σ contain approximately the whole range of scores? If all these questions can be answered in the affirmative, the particular distribution under consideration approaches the ideal. The extent to which actual measures vary from the ideal is an indication of the character of the actual distribution.

The Scatter Diagram Method of Revealing Correlation

Another method of revealing the degree of correlation between two sets of data is that of making a *scatter diagram*. This is a

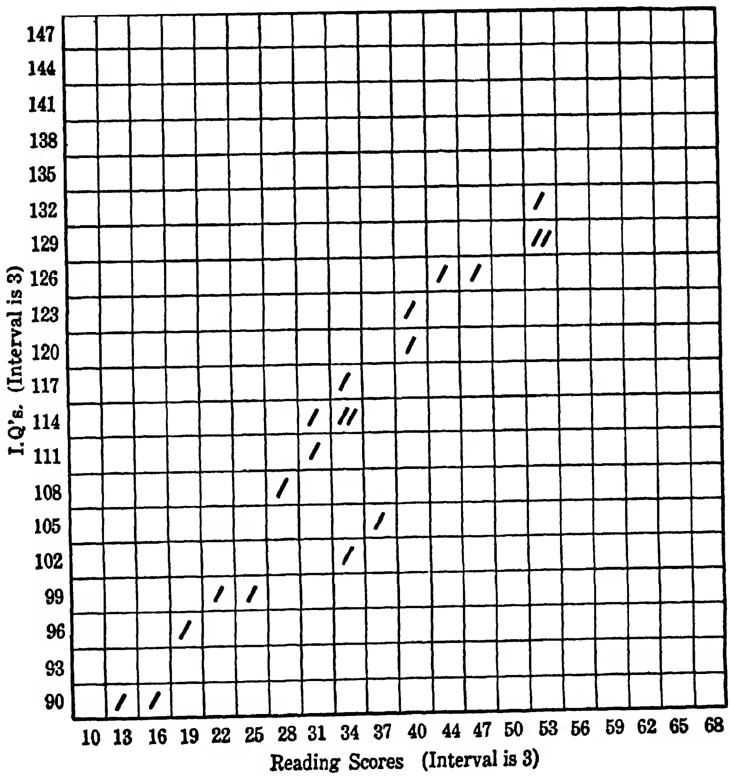

FIG. 39. Scatter diagram.

two-way frequency distribution, constructed by arranging the class intervals for one series along the left scale and those for the other series along the bottom scale, and placing a tally or dot for each pair of scores in the appropriate square or *cell*.

The degree of correlation is revealed by the tendency of the cases to fall in an alignment diagonally upward and to the right in the case of positive correlation; and downward and to the right in the case of negative correlation. No alignment indicates lack of correlation. When this occurs the tallies are scattered. The tendency for the tallies to be aligned in either direction is due to the fact that the sizes of the scores in each set of data tend to vary together in the same general or opposite direction.

While the scatter diagram does not reveal the exact degree of correlation, it does make possible a fairly accurate estimate of the amount. The advantage of the diagram lies in the fact that it can be constructed with very little mathematical calculation, and can be interpreted readily at a glance.

VALUES OF STATISTICAL MEASURES IN STUDYING TRAIT VARIATIONS

General

Our chief reason for studying statistics in educational psychology is that of being able to deal accurately with data obtained by measurements. We measure, of course, to discover similarities and differences among traits; and then we employ statistical devices to show the direction and extent of large numbers of particular measures. Without statistics nearly all measures of human traits would be meaningless. Since every trait varies in nature and amount from one individual to another, we have to establish norms or standards by measuring a trait in all or a large number of individuals. The norms, in turn, have to be stated in terms of the normal distribution. Similarities are suggested by the measures of central tendencies, while differences are suggested by measures of spread.

Specific

The mode, median, and mean are norms or standards of the extent of a particular trait because they represent the *central tendency*. Either measure indicates, in its own way the score or value around which all other measures are grouped. In a sense, therefore, these measures exhibit likenesses, resemblances, or similarities of individuals. Since there is such a central score, human beings are more alike than they are different. Nature

seems to make human beings alike by giving to each individual an amount of a trait near to that of most other individuals. Nevertheless, nature also distributes a trait to different individuals in a greater or less amount than the norm. The amount varies from one extreme to the other. The extent of the total spread is indicated by the range and the standard deviation. The range extends from the lowest to the highest measure. Between these points there should be six standard deviation units, if the total distribution is *normal.* Otherwise, the measures of central tendency are off center. Similarly, the quartiles should be located on the scale about equal distances from the median, to indicate a normal distribution. Thus norms or standards are established in terms of all the measures derived from a distribution table.

If we describe variations in such terms, we can make definite, accurate statements that become highly meaningful and significant to those who understand and speak the statistical language. So important are such measures at the present time that one has to understand them before he can read what the scientist has to say on any subject, the treatment of which depends upon measurements.

EXERCISES

1. What is meant by the *statistics of measurement?*
2. List the values which a knowledge of the statistics of measurement would have for the classroom teacher.
3. What is meant by a *frequency* or *distribution* table? What are the values of such a table?
4. What is meant by the terms *mode* and *bi-modal?* Illustrate.
5. Explain: "The mean is usually considered the most useful and accurate of the measures of central tendency."
6. Discuss the values of a *standard deviation.*
7. What is meant by *quartile deviation* and by *frequency polygon?*
8. What is meant by *normal distribution curve?* What use is made of this?
9. Justify the inclusion of a study of the statistics of measurement in a course in educational psychology.
10. Discuss the value of statistics in educational research.

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INDEX